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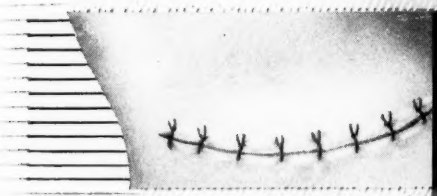

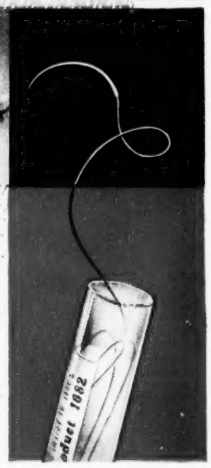

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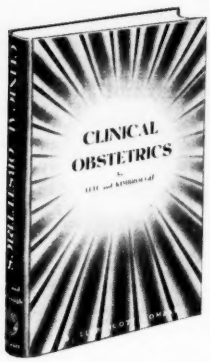
Published January 5, 1953
Second Large Printing Ordered January 21

Current methods for rational care of the pregnant patient

Clinical Obstetrics



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SURGERY
GYNECOLOGY AND OBSTETRICS

VOLUME 96 MARCH, 1953 NUMBER 3

A NEW METHOD FOR URETEROINTESTINAL ANASTOMOSIS

A Preliminary Report

WILLY MATHISEN, M.D., Oslo, Norway

THE first ureterointestinal transplantation was done by the British surgeon Thomas Smith in 1878, and since that time several different techniques have been described in the literature. They can all be divided into two main groups: the tunnel techniques, described by Coffey and others, and the direct end-to-side anastomosis, or mucosa-to-mucosa techniques, described by Nesbit, Cordonnier, and others.

The tunnel is intended to act like a valve to protect the upper urinary tract from dilatation and ascending infection. The direct mucosal anastomosis, without a tunnel, is recommended because this technique supposedly prevents stricture formation at the site of neoanastomosis, and stricture formation secondary to the normal healing process at the site of anastomosis has been considered to have been responsible for the hydronephrosis and pyelonephritis so often observed.

On a follow-up examination of 65 cases of ureterointestinal anastomosis, performed by various techniques, we found that the tunnel technique was unable to prevent intestinoureteral reflux. In a previous work (3) I was able to demonstrate on fluoroscopic examinations, during introduction of contrast medium into the rectum, that ureteral reflux occurred with an amount of fluid considerably less than necessary to produce defecation reflux. The reflux very often occurred intermittently and several times during filling of the bowel.

As to stricture formation at the site of anastomosis, we have been unable to demonstrate any sign of stenosis in 22 postmortem examinations, performed from months to several years after the operation. The methods used most have been the Coffey I and, in a few cases, the mucosa-to-mucosa technique. All cases showed dilatation of the upper urinary tract of varying degree.

In our experience, as in that of many others, the direct mucosa-to-mucosa anastomosis was apt to be followed by severe ureteral reflux and renal contamination.

The main factor in producing dilatation of the upper urinary tract, ureteral reflux, and ascending infection was the back-pressure caused by increased intracolonic pressure.

We measured the intracolonic pressure and found that it was considerably higher than that of the renal pelvis (3). The higher into the colon we proceeded, the higher the pressure—highest in the cecum. Even upon filling the rectum with 50 cubic centimeters of a saline solution, the intracolonic pressure increased to about 20 millimeters of mercury and remained longer over this value. The defecation reflex occurred at 30 to 40 millimeters of mercury or higher. Straining produced pressures over 150 millimeters of mercury. The intrapelvic and intraureteral pres-

From the Surgical Department I, Sahlgrenska Sjukhuset, Gothenburg, Sweden, and Surgical Department A, Rikshospitalet, Oslo, Norway.

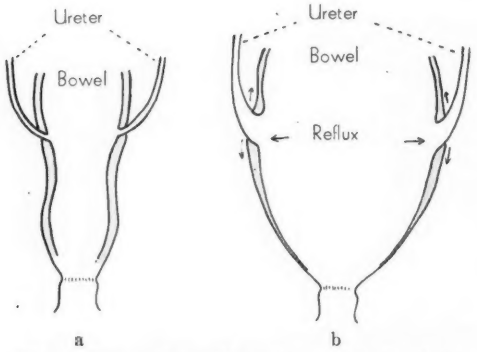

Fig. 1. The occurrence of intestinoureteral reflux during filling of the bowel in common type of ureterointestinal anastomosis. a, The bowel is empty. b, The bowel is filled.

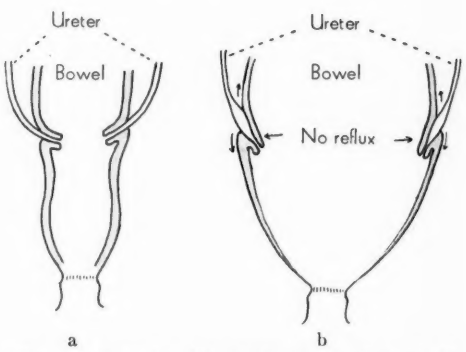

Fig. 2. The behavior of the nipple anastomosis during filling of the bowel. a, The bowel is empty. b, The bowel is filled.

sure at rest was about 7 to 10 millimeters of mercury, but increased during straining and increasing diuresis.

The most important factor in ureterointestinal anastomosis, therefore, was to construct a type of anastomosis which would prevent intestinoureteral reflux, and to keep the intestinal pressure at the lowest possible level

The explanation for the occurrence of intestinoureteral reflux is in our opinion as follows: In all common types of ureterointestinal anastomosis the opening of the ureter lies on a level with the bowel mucosa. During filling of the colon with feces, gas, and urine, the bowel will become distended by degrees, and as the ureteral stoma is attached to the intestinal wall, it consequently increases in size. When the intracolonic pressure exceeds the intraureteral pressure, ureteral reflux occurs.

In birds, where the urine normally is diverted into the rectum, the ureters open out on a small papilla or nipple. Similar conditions are found in ducts opening into the gastrointestinal tract, such as the duct of Stensen and the common bile duct.

Figure 2 illustrates what happens during filling of the colon if the ureters open out on a nipple. Some dilatation of the part of the ureter which is closely connected with the intestinal wall will develop, but the ureteral stoma is free and will not follow distention of the bowel. Due to the increased intracolonic pressure the nipple is pressed against the intestinal wall, the ureteral stoma closes, and no reflux occurs.

TECHNIQUE OF OPERATION

Based on these considerations a new technique for ureterointestinal anastomosis has been developed, the principle of which is to form a papilla for the intracolonic opening of the ureter.

The ureter is cut straight, close to the bladder, and fixed somewhat oblique to the rectosigmoid between two taenias, one suture at the end and one on either side (Figs. 3 and 4).

The bowel is incised close to the end of the ureter. The length of the incision should correspond to the circumference of the ureteral stoma. The bowel is sutured to the free end of the ureter with 5 or 6 stitches, using No. 0000 chromic catgut on an atraumatic needle. At this stage of the operation we insert a long, soft rubber tube through the ureter to the renal pelvis. The tube is connected to a bougie which has been inserted into the rectum before the beginning of the operation, and the tube is pulled out through the anus.

The length of the nipple should be about 2 to 3 centimeters. The bowel is now incised parallel to the ureter for 2 to 3 centimeters. The base of the bowel flap should be a little broader than the free cut end. The free end of the bowel flap is sutured to the end of the ureter throughout the circumference of the ureteral stoma, starting with the midline suture. The sides of the flap are united in

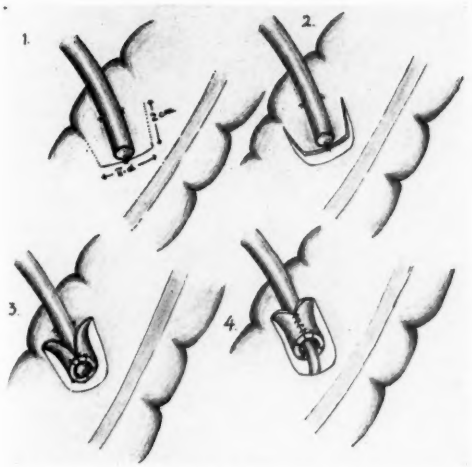

Fig. 3. The performance of the nipple anastomosis. *1*, The ureter is fixed to the bowel transversely between two taenias, one suture at the end and one on either side. *2*, The incision of the bowel. *3*, The bowel flap is sutured to the end of the ureter. *5*, The ureteral tube is inserted and the bowel flap wrapped around the end of the ureter.

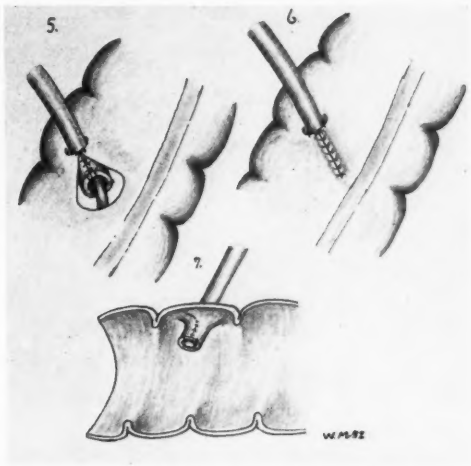

Fig. 4. *5* and *6*, Formation of the ureteral nipple is completed, and the remaining opening in the bowel is closed transversely. *7*, A section through the bowel showing the ureteral nipple.

front of the ureter with interrupted sutures of fine chromic catgut, each stitch including the outer layer of the ureteral wall. Finally, the remaining opening in the bowel is closed transversely with sutures in two layers.

DISCUSSION

Figure 5 shows an autopsy specimen from a patient who died accidentally 4 months after a ureterointestinal transplantation. There is no evidence of dilatation of the upper urinary tract, and no sign of renal lesions could be demonstrated. A section through the right ureteral nipple showed no sign of stricture formation nor of dilatation of the ureteral stoma.

The ureteral tubes are removed after 5 to 6 days, and the rectal tube—a de Pezzer catheter—is left for 2 weeks. The patient is given antibiotic therapy preoperatively and postoperatively for 2 to 3 weeks.

The method has been used in 18 cases during the last year. The postoperative results have been very encouraging and satisfactory in all cases. Excretory urograms have shown no sign of dilatation of the upper urinary tract, and we have been unable to demonstrate ureteral reflux in any case.

Fig. 5. An autopsy specimen 4 months after the operation. The bowel is opened showing the ureteral nipples. Inset, a section through the right ureteral nipple.

In order to keep the intestinal pressure at the lowest level, the patient is advised to empty his bowel frequently, at least 6 to 8 times daily, and during the night a rectal tube —a de Pezzer catheter—should be inserted into the rectum and the catheter connected to a bedside bottle. All gas-forming food, i.e., food rich in cellulose, should be avoided.

SUMMARY

The reason for the hydroureter, hydronephrosis and pyelonephritis so often observed in patients with ureterointestinal anastomosis is the back-pressure and ureterorenal reflux of fecal-contaminated urine caused by high intracolonic pressure. The two most important factors in ureterointestinal anastomosis must, therefore, be to avoid ureteral reflux and to keep the intestinal pressure at the lowest level.

The author describes a new technique for ureterointestinal anastomosis which theoretically is the best way to counteract ureteral reflux. The principle is to form an intracolonic papilla for the opening of the ureter. The method has been used in 18 cases during the last year, and the results have been satisfactory in all cases.

In order to keep the intestinal pressure at the lowest level the patient should void frequently, and have a rectal tube inserted during the night.

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SUCCINIC DEHYDROGENASE AS AN INDICATOR OF CELLULAR METABOLISM IN THE CERVICES OF PREGNANT AND NONPREGNANT WOMEN

ALVAN G. FORAKER, M.D., and SAM W. DENHAM, M.D., Atlanta, Georgia

THE morphologic changes in the cervix during pregnancy, especially certain lesions approximating intraepithelial carcinoma, have been the subject of considerable discussion in recent years. Pregnancy is itself a rapid growth process, in which many elements of the female genitalia undergo profound hormonal stimulation and radical change in size and histologic pattern. It is, therefore, not surprising that in some pregnant women epithelial changes appear that would be classified as "intraepithelial carcinoma" if seen in material derived from nonpregnant women. The exact status of this problem remains in doubt.

It, therefore, seemed of interest to study cervices of pregnant and nonpregnant women with a histochemical technique which varies in general with cellular proliferation. Tetrazolium salts as indicators of dehydrogenase activity in living cells are recent additions to the histochemical armamentarium. Neotetrazolium (NT) is reduced to an insoluble blue to black compound of the formazan group at the site of active metabolic processes. If an excess of succinate is furnished as a substrate for the reaction, much of the formazan deposition is believed to be related to the presence in the cells of succinic dehydrogenase, a vital respiratory enzyme. Using homogenization methods Meyer and McShan found a high level of succinic dehydrogenase in the corpora lutea of the rat ovary during pregnancy. They believe that this high enzyme activity is correlated with function and growth of the corpus. Stuermer and Stein demonstrated increasing succinic dehydrogenase activity in human endometrium during the proliferative phase with a fall in the late secretory phase. Tetrazolium salts have shown strong reactions with certain types of tumors and with regions of growth in plant tissues. When ovaries from rabbits undergoing Friedman tests were processed in NT with succinate (1) the pattern and degree of formazan deposition corresponded to areas of cellular proliferation.

In the present series of cervical biopsies from pregnant and nonpregnant women, dehydrogenase activity as manifested by formazan deposition corresponded closely to areas of conventionally demonstrable cellular growth and activity. Where cervical tissue from pregnant women showed increased epithelial and stromal cellular activity, increased formazan deposition was found. Qualitatively different phenomena in formazan deposition in the cervices of pregnant women were seen only in the presence of decidual reaction.

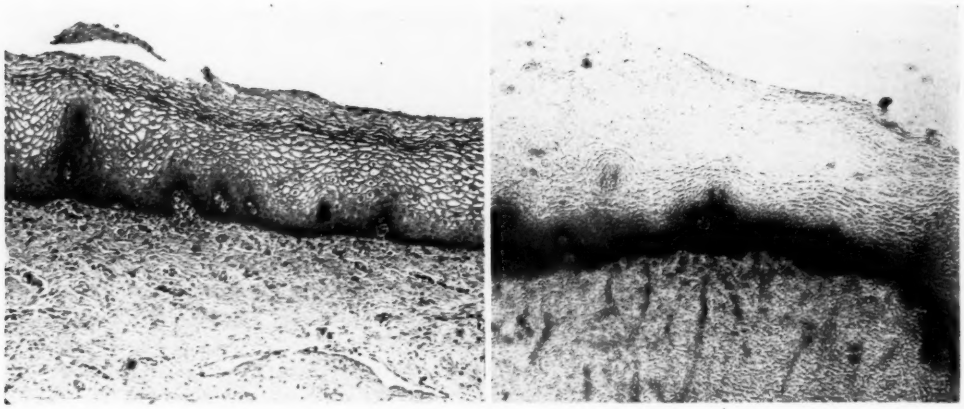
MATERIALS AND METHODS

Cervical biopsies were obtained from 55 women in normal gestation ranging from the second to the eighth month, and from 45 nonpregnant women of similar age group. These were mostly 6 to 8 weeks postpartum or were attendant in the gynecology clinic, hence do not represent a normal control group. The biopsies were taken from the apparent squamocolumnar junction, without particular search for diseased areas.

The biopsies were immediately placed in separate flasks containing 4.5 milliliters of 1 per cent NT in 0.1 M phosphate in normal saline buffered to *p*H 7.4. To each flask 0.5 milliliter of 0.3 M sodium succinate was added. Incubation with gentle agitation at 37 degrees C. for 1 hour followed with fixation in neutralized formalin. Frozen sections (15 microns) from these blocks were mounted in

From the Departments of Pathology and Obstetrics and Gynecology, Emory University School of Medicine and Grady Memorial Hospital, Atlanta, Georgia.

This investigation was supported by a research grant C-1486 from the National Cancer Institute, of the National Institutes of Health, Public Health Service.



a b

Fig. 1. a, Hematoxylin and phloxine section of portio vaginalis of cervix. b, Frozen section of same tissue after incubation in NT to demonstrate sites of dehydrogenase activity. Dark granules of reduced NT largely confined to basal layer of epithelium. Vessels in stroma lightly outlined by NT granules. ×71.

gum arabic. These sections were examined as unknowns and rated as to degree of formazan deposition by one of us (A.G.F.). The blocks were then dehydrated in dioxane, which removed all of the formazan, and embedded in paraffin, and sections (5 microns) were cut. These were stained with hematoxylin and phloxine.

RESULTS

After incubation in NT all blocks acquired a deep purple color. In the frozen sections, deposition of black or dark brown pigment was found. This pigment was largely confined to the basal layer in portio vaginalis squamous epithelium (Fig. 1). In metaplastic epithelium, a more or less diffuse formazan deposition was present throughout the epithelial layer, depending in general on the lack of maturation of the epithelium (Fig. 2). The endocervical epithelium more or less uniformly contained well defined formazan in the columnar cells, both on the surface and in the

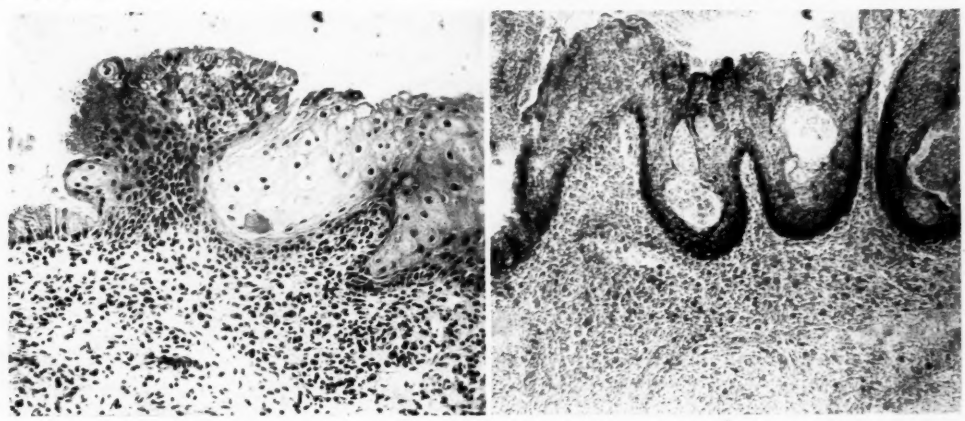


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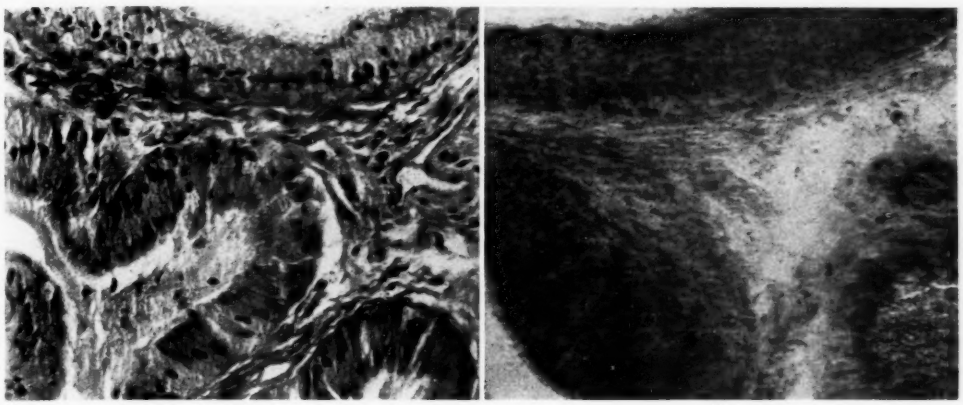
Fig. 2. a, Junction of columnar and metaplastic squamous epithelium in cervix of pregnant woman. Inflammatory reaction in stroma. b, NT section. Marked succinic dehydrogenase activity in endocervical epithelium, and diffusely through metaplastic epithelium, with optimum response at base. Reduced NT granules in leucocytes. ×156.



a b

Fig. 3. a, Glands in endocervix of pregnant woman actively secreting mucin. b, NT section. Reduced NT granules representing succinic dehydrogenase activity in glandular epithelium and about vessel. ×312.

glands (Fig. 3). A few nabothian cysts with flattened epithelium revealed much less intracellular deposition. The gland lumens contained no extracellular formazan and there were no pigment granules in the inspissated secretion of distended goblet cells.

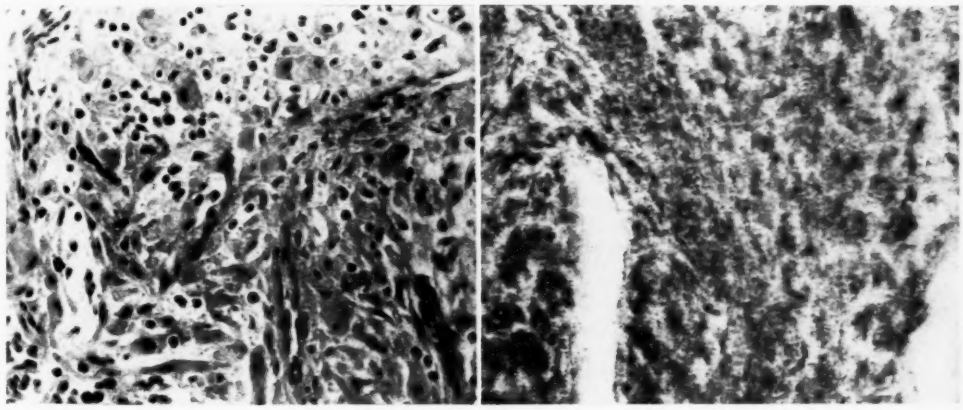
Usually the stroma revealed light formazan deposition with the following exceptions:

1. All of the vessels were outlined by pigment granules (Figs. 1 and 3).

2. When the stroma was inflamed, increased formazan deposition was seen. Often formazan granules were noted within leucocytes (Fig. 2).

3. In 5 biopsies from pregnant women showing decidual reaction, the decidual cells contained concentrated aggregates of formazan filling the cytoplasm, but leaving relatively clear areas corresponding to the location of nuclei (Fig. 4). The degree and clarity of cellular formazan deposition in these biopsies conformed to the floridity of the decidual reaction as seen in conventional sections from the same blocks.

On preliminary examination of the NT sections alone, biopsies from pregnant women were correctly allocated in 78.2 per cent of



a b

Fig. 4. a, Decidual reaction in cervix of pregnant woman. b, Heavy deposition of reduced NT in decidual cells representing marked succinic dehydrogenase activity. Clear areas in centers of cells indicate locations of nuclei. ×312.

cases and those from nonpregnant women in 73.3 per cent of cases. However, it soon became apparent that this differentiation was partly based on the general architectural pattern of the tissue (e.g., "glandular hyperplasia" in pregnant women), which could be identified in many cases, rather than on intensity of formazan deposition alone.

When hematoxylin and phloxine stained sections were examined in comparison with the NT sections, the general appearance of the tissues and incidence of inflammatory reaction, squamous metaplasia, glandular activity, vascularity, and other phenomena in material from pregnant and nonpregnant women conformed to those of published series (5, 6).

One case is worth noting briefly with relation to intraepithelial carcinoma and cervical dehydrogenase activity in pregnancy:

B.G., a 19 year old white woman was seen with a friable cervical erosion on June 9, 1951, two months after her second delivery. A biopsy of this was reported as chronic cervicitis with squamous metaplasia. On March 8, 1952 she was seen in the twenty-fourth week of her third gestation and a marked chronic cervicitis was noted. A biopsy at this time showed no normal squamous epithelium. The epithelium exhibited complete lack of maturation, large dark nuclei, many mitotic figures and all of the other features of intraepithelial carcinoma. No invasion was found in this material. The third biopsy was taken June 9, 1952 in the thirty-eighth week of gestation and blocks were processed in NT. In conventional sections the atypical epithelium was again found, extending far down into glands and along the surface. Sharp areas of demarcation of atypical and portio vaginalis type epithelium were seen (Fig. 5a). Other sections were of endocervical tissue with decidual reaction. In the NT sections, heavy formazan deposition was seen throughout the atypical epithelium, but the black pigment was found only in the basal layer of the portio vaginalis type epithelium. Sharp borders of demarcation between the two patterns of formazan deposition corresponded to the areas of demarcation seen in conventional sections (Fig. 5b). A diagnosis of squamous cell carcinoma of the cervix, probably still in situ, was returned. Normal spontaneous delivery terminated pregnancy June 17, 1952.

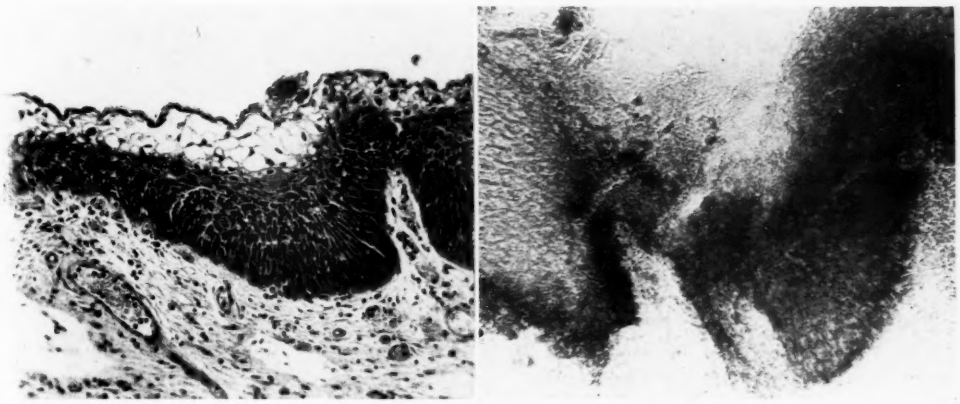
On August 7, 1952 the cervix still presented a reddened granular appearance proximal to the external os. A wide conization was done. Sixteen hematoxylin and phloxine sections were prepared from areas equidistant about the compass. Most of these revealed intense chronic cervicitis with an active appearing metaplasia. In two sections, high in the endocervix, strips of superficial epithelium retained the histologic appearance of intraepithelial carcinoma. Each of these neoplastic areas was less than 1 millimeter in length, with no invasion and minimal extension into glands. In 4 additional NT blocks, only one superficial area at the endocervical junction, less than 0.6 millimeter in length retained the formazan deposition pattern previously seen in intraepithelial carcinoma, in this and other patients.

DISCUSSION

No qualitative differences in succinic dehydrogenase activity were found between cervical biopsies of pregnant and nonpregnant women, with the exception of heavy formazan deposition in decidual cells. The differences in amount of formazan deposition in the various tissue components correlated rather closely with histologic evidence of cellular activity as seen in conventional sections. Since the biopsies from pregnant women had more inflammatory reaction, glandular hyperplasia, and squamous metaplasia with intrinsic evidence of cellular activity, these areas might be expected to show more evidence of dehydrogenase activity. In this connection there is said to be an excellent correlation between the oxygen consumption of tissue as measured by the conventional Warburg technique and formazan deposition. The portio vaginalis epithelium of pregnant and nonpregnant women had no essential difference in pattern of formazan deposition.

The findings of intense formazan deposition through the layers of atypical squamous epithelium in the case noted casts little light on the unsettled problem of intraepithelial carcinoma in pregnancy. We have found evidence of marked succinic dehydrogenase activity in florid but obviously non-neoplastic squamous metaplasia in pregnant and nonpregnant women. Similarly heavy formazan deposition occurs in undisputed intraepithelial and invasive squamous cell carcinoma of the cervix in nonpregnant women, in our experience. Strong reaction of a tetrazolium salt with cells from squamous cell carcinoma of the cervix has been described by Mackenzie and Fuller.

The present study lends histochemical support to the concept that there is cellular proliferation and growth in the cervix in pregnancy. In the metaplastic area of the squa-



a b

Fig. 5. Junction between normal and neoplastic epithelium in case cited. a, Hematoxylin and phloxine section. On the left is epithelium with maturation; on the right, the histologic pattern of intraepithelial carcinoma. b, NT section. On the left, epithelium with evidence of succinic dehydrogenase activity confined to the basal layer; on the right, evidence of diffuse succinic dehydrogenase activity throughout the epithelial layer. ×156.

ous epithelium of pregnant women there was evidence of increased growth or proliferation of this tissue by the method used. Nearby there was seen evidence of glandular hyperplasia and increased metabolic activity of the stroma and vessels. Apparently the area of optimum response of the cervix in pregnancy, as seen in this study, corresponds to the area of most frequent development of cervical carcinoma (2). We did not find evidence of increased metabolic activity of the portio vaginalis epithelium of the cervix in pregnancy.

Reviewing available knowledge on the subject, including our own experience, four possibilities must be considered regarding the appearance of noninfiltrating neoplastic-like change in the cervix in pregnancy in any individual case:

1. This represents a malignant neoplasm, which will not regress materially after delivery and may become invasive at any time. Since the age incidence for intraepithelial carcinoma overlaps that for pregnancy, this must be true in certain cases.

2. After delivery the neoplastic pattern may regress so that it is difficult or impossible to find, but will remain a focus of potentially malignant growth.

3. This appearance of neoplasia may be a temporary phenomenon, but indicates women whose cervices are abnormally sensitive to hormonal or other stimuli, and who under the influence of additional factors may develop intraepithelial or invasive carcinoma subsequently.

4. This may be an evanescent change, occurring under the stimulus of pregnancy, which will disappear and have no bearing on the future of the cervix or of the patient.

In the present state of our experience we are unable to choose among these, or to indicate that any of them may represent the entire truth, applicable to all patients. If some of the pregnant women presenting this degree of anaplasia of cervical epithelium have intraepithelial carcinoma, while others do not, we cannot differentiate the two groups, either by morphologic criteria, or on the basis of succinic dehydrogenase activity.

SUMMARY

Cervical biopsies from 55 pregnant and 45 nonpregnant women were incubated in neotetrazolium with succinate to determine sites of succinic dehydrogenase activity. Decidual cells in biopsies from pregnant women gave evidence of a high level of dehydrogenase activity. Otherwise, sites of dehydrogenase activity corresponded well to sites of cellular proliferation as seen in conventional sections.

Included in the study was a case of intraepithelial carcinoma of the cervix which was followed through pregnancy. The neoplastic areas showed marked succinic dehydrogenase activity.

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TREATMENT OF CHRONIC HEMATOGENOUS OSTEOMYELITIS BY MEANS OF SAUCERIZATION AND BONE GRAFTING

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DURING World War II, the abundance of compound comminuted fractures, with the accompanying infection and subsequent persistent drainage, and the advent of antibiotic agents to control infection made it only natural that some courageous and enterprising surgeons should attempt bone grafting in the face of infection, and that others, even more venturesome, should suggest or use bone grafts in the treatment of chronic hematogenous osteomyelitis.

PREVIOUS WORK

In 1944, Mowlem reported a series of cases in which cancellous bone from the ilium was used to fill mandibular defects. In 3 cases grafting was carried out in the presence of a known opening into the mouth, and in many cases within a few days of cessation of discharge.

In 1945, Knight and Wood reported 23 cases in which traumatic osteomyelitis was treated by saucerization, split thickness skin grafts and, later, grafts of iliac bone to fill the bony defect. The wounds in all but 2 of their cases had healed at the time of their report.

Robertson and Barron, in 1946, presented a method of treating selected patients with chronic osteomyelitis by excision of all diseased tissue and split thickness skin grafting, followed by replacement of defects in the bone with cancellous bone, using cortical bone only when needed to aid in bridging substantial gaps.

Kelly, Rosati, and Murray reported failures in 7 of 14 cases in which iliac bone chips were used to fill the defects resulting from posttraumatic osteomyelitis. In 1946, Prigge also employed grafting with cancellous iliac bone in the treatment of chronic posttraumatic osteomyelitis with eventual success in 16 of 20 cases. During the same year a fourth series of cases was reported by Coleman and his coworkers, who advocated a single stage procedure of saucerization, bone grafting, and closure. Using this method they reported success in 92 per cent of 52 defects in bone complicated by infection. Included in this series were 2 cases of chronic hematogenous osteomyelitis, in both of which healing occurred without incident.

In 1947, DeCamargo of Brazil reported on chronic hematogenous osteomyelitis in 2 children, aged 7 and 12 years, which he treated by radical saucerization, packing of the cavity with autogenous, cancellous iliac bone, and primary closure. Penicillin was administered before and after operation. Primary healing occurred. Follow-up examination in 14 months revealed excellent blending of the graft with the host bone.

Metcalfe, in 1948, reported primary healing of a Brodie's abscess in the tibia after saucerization, packing with iliac bone chips, and primary closure without drainage. Penicillin was given locally as well as parenterally.

In 1949, Hogeman, reporting his experience in 11 cases, confirmed the observation previously made by Coleman and associates that, although skin necrosis might occur and expose the bone grafts, the bone grafts need not be removed because sequestration is feared. After necrosis cleared up in his cases, the exposed grafts were gradually covered by granulation tissue which, in turn, was covered by split

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thickness skin grafts. In 10 of Hogeman's 11 cases, healing occurred and was maintained at follow-up periods ranging from 6 to 24 months. In 5 of these cases healing occurred in spite of skin necrosis. The chronic osteomyelitis was posttraumatic in 7 of his cases. In all his cases cavities formed by saucerization were irrigated with penicillin, and penicillin was administered parenterally in the postoperative period.

In 1950, Fehr and Cathomas of Switzerland reported results of studies on rabbits. Six weeks after the experimental production of osteomyelitis by decortication of the tibia and introduction of organisms into the medullary cavity, radical saucerization of the infected tissue, filling of the defect with iliac bone chips, and primary closure were carried out. Depot penicillin was given postoperatively. In 10 animals, 9 grafts healed primarily and the grafts were consolidated at 3 months. One animal died because of inadequate excision of infected tissue.

In chronic osteomyelitis resulting from a blood-borne infection and chronic osteomyelitis secondary to infected compound fractures, the problem is essentially the same. In posttraumatic osteomyelitis, however, the infection usually is of shorter duration. The resultant sclerosis of bone is not so pronounced, and the soft tissues tend to be less scarred and devitalized. In general, therefore, surgical eradication of the infection in the localized posttraumatic form of chronic osteomyelitis is not so difficult as the eradication of an area of chronic hematogenous osteomyelitis. In chronic hematogenous osteomyelitis, the most persistent infections are in the areas in which obliteration of abscess and saucerization of cavities are most difficult. Usually these areas are in the lower end of the femur, both ends of the tibia, the lower humerus, and abscesses about old ankylosed septic joints. In posttraumatic chronic osteomyelitis the cavities often are more easily obliterated without bone grafts.

In recent years, since antibiotics have come into common use, interest has centered around methods of obliterating these bone cavities. The cavity may be excised, split thickness skin grafts applied, and, if necessary, late bone grafts, pedicle grafts, or muscle flaps can be used to fill the defect. The cavity may be excised and bone grafted immediately, or the cavity may be packed open for a varying period and bone grafts inserted later. In either case, primary closure may be done.

The use of bone grafts in chronic hematogenous osteomyelitis allows more complete excision of the infected bone down to healthy bone with a good blood supply; this procedure also permits better dispersal of the antibiotic agent and new blood supply throughout the bone grafts and to the skin flaps. The end result of treatment with bone grafting is a more vascular structure than would result if the cavity were allowed to granulate in and fill with avascular scar tissue, which is a potential source of recurrent infection leading to abscesses and breakdown of the scar.

The unpleasantness of a gaping, packed osteomyelitic wound is familiar to all (although it is becoming increasingly rare), and any method of treatment which will shorten this period is certainly acceptable. Frequently bone grafting will accomplish this objective and reduce the period of disability. With the aid of antibiotics, bone grafting can be carried out with little risk to life since generalized dissemination of the infection no longer is such a great hazard. In the event of failure, necessitating removal of the bone chips and packing of the wound, relatively little time is lost by the attempt to obliterate the cavity and to obtain primary healing. A second trial can be made and is often successful.

CASES STUDIED

Undoubtedly, by this time, many surgeons have used bone grafts in the treatment of chronic hematogenous osteomyelitis, but since reports of such cases are not numerous, a summary of the results of our experience in this regard may be of interest. Thirty-six patients with chronic hematogenous osteomyelitis have been treated by bone grafting at the Mayo Clinic prior to January, 1951. Results of operation were classed only as successes or failures according to data obtained at follow-up examination or from last report of patient. The operation was considered to be a failure if healing had not been maintained. The pa-

tients were from 13 to 71 years old. For most patients drainage, either continuous or intermittent, had been present for a long time. Nine patients had never had any drainage. Of these, 4 had Brodie's abscesses, 1 had sclerosing osteomyelitis, and the condition of the remaining 4 had flared only to a subacute state without drainage when it was controlled by chemotherapy. The duration of the disease was: 20 to 50 years in 14 cases with 9 successes and 5 failures; 10 to 19 years in 11 cases with successes and 2 failures; 1 to 9 years in 1 cases with 10 successes and 1 failure; that a total of 36 patients with 28 successful ases and 8 unsuccessful. In 19 of the 36 cases he tibia was the site of the osteomyelitis and 14 the femur was involved. In 1 case the alcaneoid bone and heads of the first and second metatarsal bones were involved; in another case the cavity of the abscess was in the sclerotic bone of an ankylosed knee, and in 1 case the os calcis was the site of a Brodie's abscess.

TABLE I.—RESULTS OF CULTURE OF MATERIAL FROM INFECTED BONE IN 36 CASES OF CHRONIC HEMATOGENOUS OSTEOMYELITIS

Organism produced, or result	Cases	Treatment	
		Success	Failure
Micrococcus pyogenes (Staphylococcus aureus)	21	17	4
Micrococcus pyogenes plus Escherichia coli	1	1	0
Micrococcus pyogenes plus hemolytic streptococci	1	1	0
Brucella abortus	1	1	0
Aerobacter aerogenes and Proteus	1	0	1
Nonhemolytic streptococci plus micrococci	1	0	1
Negative culture	6	6	0
Culture not done	4	2	2
Total	36	28	8

OBSERVATIONS AND RESULTS

Results according to duration of the disease have been given and according to duration of follow-up were: more than 2 years in 16 cases with 13 successes and 3 failures; 1 to 2 years in 12 cases with 9 successes and 3 failures; 9 weeks to 1 year in 8 cases with 6 successes and 2 failures; or a total of 36 cases with successful results in 28 and failures in 8.

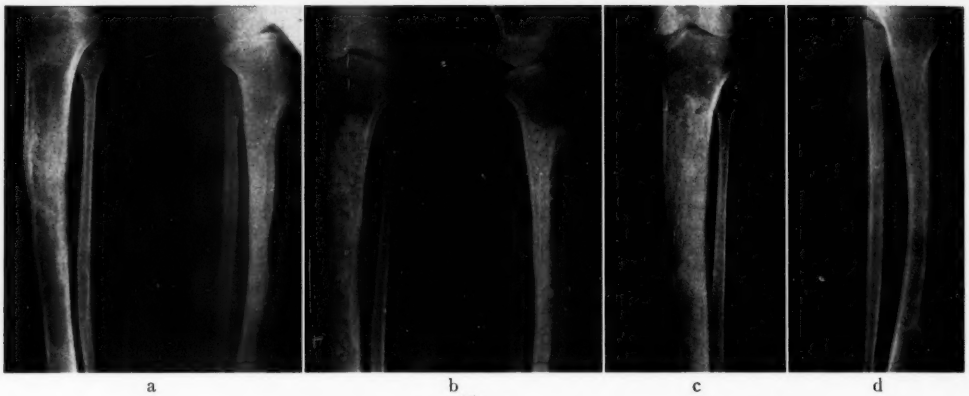
Organisms encountered. The results of preoperative or operative culture are shown in Table I. Micrococcus pyogenes var. aureus (Staphylococcus aureus) was the infecting organism most frequently encountered either by itself or with Escherichia coli or hemolytic streptococci. The case of brucellosis has been previously reported by Lowe and Lipscomb. In 2 cases no material suitable for culture was obtained as only sclerotic bone was removed. One patient was first seen after saucerization and split thickness skin grafting had been done elsewhere, and in 1 case, because of a misunderstanding, culture was not carried out. The result of culture was negative in 6 cases. Seventeen wounds drained to some extent after operation. In 7 cases this drainage was described as serosanguineous. In 5 of the 17 cases the eventual result was failure. Culture was carried out in 8 of the 17 cases and the following organisms were identified: Micrococcus pyogenes var. aureus in 3, Escherichia coli in 2, Proteus in 2, Corynebacterium xerose in 1, Aerobacter aerogenes in 1, and Pseudomonas in 1.

Antibiotic agents employed. Penicillin was administered before and after operation to all except 2 patients. One of these 2 was suffering from an osseous infection caused by a combination of Aerobacter aerogenes and Proteus and was treated with 96 grams of chloramphenicol (chloromycetin), but failure was the final result. The other patient was allergic to penicillin and was treated with dihydrostreptomycin. Another patient received sulfadiazine and a 10 day course of streptomycin because severe urticaria developed after 10 days of treatment with penicillin. Aureomycin was used when resistance of the infecting organism to penicillin was demonstrated.

Penicillin was administered preoperatively for from 1 to several days. Early in the series the dose was usually 50,000 units every 3 hours to ensure an adequate concentration of the antibiotic in the blood at the time of operation. Later depot administration of either 300,000 or 600,000 units of penicillin once daily was used. Use of penicillin or other antibiotic of choice was continued after operation for 2 to 4 weeks, depending on the clinical

a b c d

Fig. 1.



a b c d

Fig. 2.

Fig. 1. a and b, Left tibia anteroposterior and lateral views after saucerization and split skin graft to cavity. c and d, Anteroposterior and lateral views 4½ months after excision of skin graft, and performance of iliac bone graft to cavity and primary closure.

Fig. 2. Right tibia. a, After saucerization and open healing followed by recurrent acute episodes of infection. b, Two months after further saucerization, bone grafting, and primary closure. c and d, Two and a half years after operation.

course. In 9 cases penicillin was mixed with the bone grafts at the time of operation in order to provide high local concentration. In 10 cases a more prolonged effect was obtained by the use of penicillin in beeswax and peanut oil or, in more recent cases, procaine penicillin in sesame oil. A mixture of sulfathiazole and penicillin was used in 11 cases and sulfathiazole alone was used in 4 cases. It cannot be ascertained on the basis of this small series whether or not the local use of penicillin is of any value. In 6 of the 8 cases in which the result was a failure, penicillin in some form had been instilled at the time of operation.

Surgical procedures. The types of surgical procedures used and the results obtained were: saucerization and immediate bone grafting in 19 cases with 15 successes and 4 failures; saucerization, packing, and later bone grafting in 16 cases with success in 12 and failure in 4; saucerization and packing followed by skin grafting with bone grafting later in 1 successful case; or a total of 36 cases with 28 successes and 8 failures. The operation in all cases consisted of excision of as much of the diseased bone and soft tissue as possible down to healthy, bleeding bone. In 19 cases packing of the cavity with bone chips and closure

Fig. 3. a and b, Lower part of right femur (anteroposterior and lateral views). Abscess in acute osteomyelitis untreated. c and d, Two weeks after saucerization and 1 day after bone grafting and tight closure. e and f, One year after operation showing good healing. No symptoms or recurrence.

of the skin were carried out immediately after saucerization. Closure of the wound was usually made possible by undermining of the edges of the skin, although in some cases plastic procedure, such as transplantation of a flap of healthy skin over the defect and split thickness skin grafting the donor area, was necessary.

Two patients in the group who underwent immediate grafting and primary closure deserve special mention because of the course.

CASE 1. A young man, 26 years old, had had chronic hematogenous osteomyelitis for 13 years. After operation in January, 1949, slight drainage persisted from the tibia operated upon for 8 months until 1 small sequestrum and 2 stainless steel wire sutures were removed. Granulation then occurred and pinch grafting was done 5 weeks later. Ten months later a sinus and 3 small sequestra were removed at a distance from the area previously saucerized and grafted. Follow-up examination 16 months later revealed that the wound had remained healed. The transplanted autogenous iliac bone was never removed, and an early partial failure became a successful result.

CASE 2. The patient, a woman, 70 years old, gave a history of having had chronic osteomyelitis of the tibia for 59 years. At operation bone from the bone bank was employed for the grafting. In spite of undermining the edges of the skin, the wound was closed under an appreciable amount of tension. After operation the edges of the skin separated, and intermittent drainage and crusting occurred for the

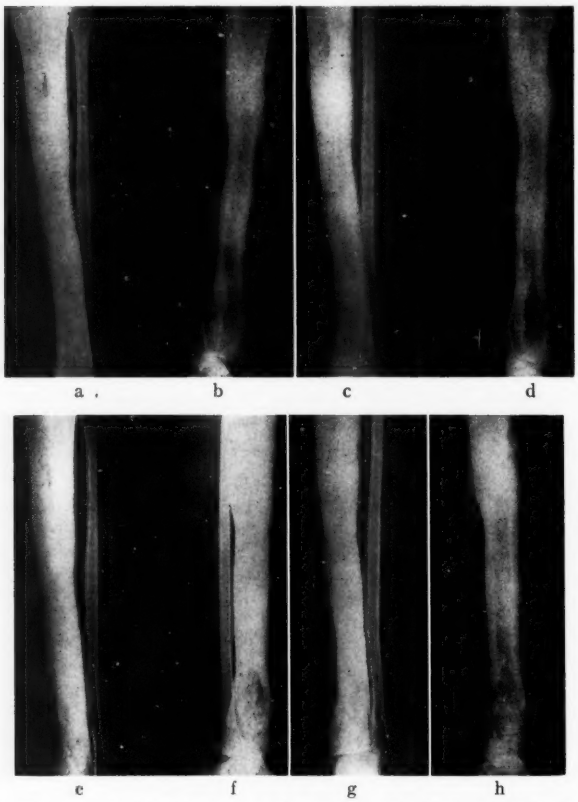


Fig. 4. Left tibia (anteroposterior and lateral views). a and b, On admission; 21 year history of drainage and multiple operations. c and d, After saucerization prior to bone graft. e and f, After insertion of an autogenous bone graft and closure. g and h, Four and a half years after bone graft. Patient is clinically well.

next 7 months, at which time it was decided to explore the area and provide an adequate skin covering. At operation it was noted that the grafts had blended perfectly with the host bone. More bone from the bank was added, and more extensive undermining of the skin was done. The operative wound healed in 14 days and had remained so at the time of follow-up examination 7 months later. The provision of an adequate cover of soft tissue to the bone graft turned another early failure to a successful result.

In the 16 cases in which the procedure was saucerization, packing, and later bone grafting, the cavity was packed with petrolatum or nitrofurazone impregnated gauze after excision of the involved bone. After a period of observation, varying from 7 days to 4 months, the cavity was packed with bone chips and the wound was closed. At the time of grafting some cavities were cleaned of their granulation tissue and others which appeared healthy enough were not curetted. Grafts were placed within 2 weeks of saucerization in 11 cases and from 2 to 6 weeks in 2 cases. One graft was placed 3½ months after saucerization with a successful end result. In the remaining 2 cases bone grafting was carried out 4 months after saucerization. In 1, failure occurred and the leg was amputated 4 months later.

In 1 case grafting with autogenous iliac bone chips was carried out 10 months after

saucerization and split thickness skin grafting (Fig. 1a and b) had been performed elsewhere. Intermittent drainage had been present in this case, probably because of maceration of the skin graft in the depth of the cavity. His wound had healed in 23 days after bone grafting and remained so 3½ years. Figure 1c and d shows the status of bony healing at 4½ months.

Types of grafts. Results according to the type of grafts used were: autogenous iliac in 11 cases with 10 successes; homogenous (frozen bank) in 20 cases with 15 successes; autogenous and homogenous in 5 cases with 3 successes; or a total of 36 cases with 28 successes. Of 8 failures (22.2 per cent) in the 36 cases, 5 occurred when homogenous bone alone was used, 2 when homogenous bone was used to supplement autogenous iliac bone, and only 1 failure occurred when autogenous iliac bone was used alone. Of the 5 failures when frozen homogenous bone from the bone bank was employed, 3 followed immediate grafting after saucerization and 2 followed grafting after a delay of 2 weeks and 4 months respectively. In 1 of the 2 cases in which failures followed autogenous iliac bone supplemented by homogenous bone, immediate grafting and closure were employed, and in the other case the cavity was packed 2 weeks before grafting and closure. The only failure when autogenous iliac bone was used was in a case in which grafting was done 2 weeks after saucerization, and in which inability to control infection with antibiotics led to removal of the grafts. In 5 cases in which autogenous bone grafts were successful, the grafting and closure were done immediately after saucerization.

Bone from the bone bank used in this series consisted of frozen segments of ribs which had been obtained as by-products of sterile thoracic procedures. These ribs were cut into small pieces at the time of use and, of course, contained a higher proportion of cortical bone than the autogenous iliac bone used as grafts. In those cases in which the supply of autogenous iliac bone was found to be ample, the cortex was discarded and only cancellous chips used.

Experimental work has shown that transplanted cancellous bone is vascularized quicker than transplanted cortical bone. It may be that early vascularization endows transplanted spongy bone with the ability to resist the inevitable residual infection in these cases of chronic hematogenous osteomyelitis treated by saucerization, immediate or delayed bone grafting, and primary closure. Pieces of cortical bone persisting for an appreciable period as unvascularized foreign bodies may well decide the issue of success or failure. In all types of grafting procedures, it has been our impression, that autogenous bone, if it is available, is superior to bone from the bone bank.

Time required for healing after operation. Of the total 36 cases there were 28 successes and 8 failures. Although a fifth of the operative wounds exhibited some serosanguineous drainage, the great majority healed completely in 2 to 3 weeks: 23 cases with 21 successful and 2 unsuccessful results.

Four wounds exhibited delayed healing up to 3 months after operation. All 4 operations were eventually classified as successful. For 1 of these patients bone grafting had been carried out 4 months after the preliminary saucerization. Healing required 2 months, but 3¼ years after the second operation, the patient wrote that there had been no recurrence of drainage since the wound healed. In a second patient, who had extensive osteomyelitis of the tibia of 12 years' duration (Fig. 2a), immediate bone grafting and primary closure of the skin over the anterior part of the tibia had been done. A narrow strip of skin sloughed from the middle of the incision, and more than 2 months were required for healing. Figure 2b shows the result at 2 months, and Figure 2c shows the bone graft to be healed satisfactorily 2½ years after operation, and the patient is having no further trouble with his leg. A medullary cavity appears to have developed in the grafted bone. The third case in this group of 4 in which healing was delayed is another example of an apparent early failure, but a late success. It is given in some detail as follows:

CASE 3. This patient had had osteomyelitis of the lower end of the tibia for 30 years and was treated by saucerization, followed in 12 days by grafting with autogenous iliac bone. Closure was effected by

swinging a skin flap over the grafted area. An area, approximately 4 inches by 2½ inches (10.2 by 6.4 cm.) sloughed and when the tissue was excised, the underlying fragments of bone were exposed. They were allowed to remain in situ and the denuded area was covered with multiple split thickness skin grafts about the size of postage stamps. However, 4 months after the bone grafting procedure, persistent drainage developed in the skin grafted area. Ten months after the original operation, the sinus tract was excised, and a small superficial sequestrum was removed. The area surrounding this was saucerized for a distance of about 1½ inches (3.8 cm.). The grafts previously applied had blended in so well that it was difficult to distinguish them from the remainder of the bone. The wound was closed and it healed by primary intention. Fifteen months after this, or more than 2 years after the original operation, roentgenograms showed a small cavity at the site of the second sequestrectomy. Drainage had not occurred, and the patient was continuing to work as a barber.

The remaining patient who had delayed healing up to 3 months after operation required a sliding pedicle graft with a split thickness skin graft to the donor site for adequate coverage with skin. Healing was complete in 4 weeks and the patient wrote at the end of a year that he was still well.

There were 9 patients whose wounds were not healed more than 3 months after operation. Of these 3 obtained a successful result and 6 were unsuccessful.

CASES OF SPECIAL INTEREST

Of interest are 2 cases in which the operation was successful.

CASE 4. A girl, 13 years old, gave a vague history of a swollen, painful right knee after mild trauma 5 years previously, with complete freedom from symptoms until 5 weeks prior to our initial examination when she became febrile and the same knee became painful, hot, swollen, and tender. Roentgenograms taken on admission to the Mayo Clinic revealed an area of decreased density in the lower part of the femur (Fig. 3a and b). At operation, after opening the sclerotic cortex, copious amounts of frank pus, which produced Micrococcus pyogenes when cultured, were encountered. This bone abscess was saucerized and packed for 2 weeks, following which the defect was filled with bone from the bone bank. She received both penicillin and aureomycin to control the infection. Figure 3c and d shows the area in the femur immediately after bone grafting. A year later (Fig. 3e and f) healing was complete and knee motion was normal.

CASE 5. The patient, a man, 35 years old, gave a history of having had intermittent drainage from the tibia for 21 years. The initial roentgenogram is shown in Figure 4a and b. The area of osteomyelitis was first saucerized and packed at intervals for 3½ months (Fig. 4c and d) until a second operation was performed and autogenous iliac bone was transplanted into the cavity and primary closure done (Fig. 4e and f). Healing occurred in 14 days, and roentgenograms 4½ years later (Fig. 4g and h) show that the bone grafts have consolidated and there is no clinical evidence of infection.

ANALYSIS OF CASES IN WHICH FAILURES OCCURRED

CASE 6. One of the failures occurred in a man, 28 years old, in whom, at the age of 16 years, septic arthritis of the left knee had developed after acute frontal sinusitis with osteomyelitis of the frontal bone. Saucerization and immediate grafting of bone in the area of the ankylosed knee were carried out because of persistent drainage from a cavity in the bony ankylosis. Although the wound had healed in 18 days, the patient returned 9 months later, saying that the wound had drained and healed repeatedly and that several sequestra had been extruded since his dismissal.

In this case the anatomic location of the cavity had precluded adequate excision down to healthy bone.

CASE 7. The patient, a man, 43 years old, had had almost continuous drainage from the upper third of the left tibia since drainage of a Brodie's abscess at the age of 21 years. At operation the sinus tract was excised and was found to be lined by stratified squamous epithelium which showed areas of low grade squamous cell carcinoma. Excision of the osteomyelitic cavity and immediate grafting was carried out, but on the eighth postoperative day brownish, foul-smelling fluid drained. Culture revealed Proteus vulgaris which was sensitive to streptomycin. Streptomycin therapy was instituted, but had to be discontinued after 5 days because of involvement of the eighth cranial nerve. Three weeks after bone grafting the cavity was reopened, the bone chips were curetted out and the wound was packed open. Amputation was performed elsewhere a year later.

CASE 8. Failure also occurred in the case of a man, 35 years old, who had had constant drainage from the anterior aspect of the left tibia for 22 years. The tibia was saucerized for a distance of about 8 inches (20.3 cm.). The bone was very dense and sclerotic, but pus was not encountered. The defect was filled with fragmented segments of ribs from the bone bank. The wound was closed by undermining the skin, but after removal of the sutures, the edges of the skin separated, exposing the bone chips. The grafts seemed to be in good condition and in a good vascular bed, but it was felt wiser to remove them rather than to risk sequestration. A sliding skin

flap procedure was then carried out. Three months later the patient still had a drainage sinus. The latest follow-up report revealed that the sinus had been closed for the past year and a half.

The failure in this instance doubtless was due to inadequate coverage of the grafts. In the light of present experience, however, the majority of the bone grafts possibly could have been salvaged if they had been left in place and a secondary plastic closure carried out.

CASE 9. A man, 47 years old, had had a Brodie's abscess in the tibia for 32½ years. At operation the walls of the cavity were broken down, but saucerization would have weakened the bone to the point of fracturing. Homogenous bone was packed into the defect immediately and the incision closed primarily. The operative wound was healed in 14 days, and healing was present when a cast was removed at 2½ months after operation. However, the patient has written since his last examination and says that drainage has recurred.

CASE 10. The infection which had been present for 35 years in the region of an ankylosed knee was markedly resistant to antibiotics. Homogenous bone was implanted after a delay of 2 weeks. Necrosis of wound edges occurred and Aerobacter aerogenes was cultured from the drainage. Ninety-five per cent of postage stamp skin grafts applied 6 weeks later took successfully, except for 1 small devitalized spot where a slight protuberance persisted. Persistent drainage necessitated a sequestrectomy 5 months later and roentgenographic study the following month revealed some absorption of the bone grafts.

CASE 11. The patient, a woman 62 years old, had chronic osteomyelitis in the femur. Culture revealed a strain of Aerobacter aerogenes sensitive to penicillin, but an insensitive strain of Proteus vulgaris. After saucerization and packing for 2 weeks, autogenous iliac bone and bone from the bone bank were used to fill the cavity. Chloramphenicol was administered, but the wound never healed and the Proteus vulgaris persisted in the drainage. Six months after grafting the bone grafts were removed and the defect allowed to heal in from below.

CASE 12. A man, 46 years old, who had had drainage from the femur for 31 years was treated by sequestrectomy and saucerization, followed 4 months later by homogenous bone graft. Culture revealed Escherichia coli insensitive to streptomycin and aureomycin. Later cultures revealed the addition of Pseudomonas, Micrococcus pyogenes, Proteus vulgaris, and Streptococcus faecalis. Amputation of the open flap type through the midthigh was performed 4 months after bone grafting.

CASE 13. The patient, a young man, 26 years old, with a history of intermittent drainage from the tibia over a 16 year period, was treated by saucerization, packing of the cavity for 2 weeks, and then grafting with autogenous iliac bone. Nonhemolytic streptococci and a micrococci of undetermined species were found on culture of material from the infected area before operation. In spite of administration of penicillin and aureomycin, the operative wound never healed, and at a later date Pseudomonas was recognized in the drainage. Persistent infection forced the removal of the bone grafts and the remaining open cavity is being allowed to heal in from below.

COMMENT

When a patient presents himself with an acute flare-up of chronic hematogenous osteomyelitis, it is considered better judgment to treat the patient with antibiotic agents until the condition returns to a subacute or chronic stage before definitive surgical treatment is carried out. The other alternative is to treat such a patient by the standard method of incision and drainage or saucerization, and to pack the wound open until the acute flare-up is under control.

Considerable forethought must be given to the matter of the covering of the bone-grafted area, and a decision must be made as to whether sliding or pedicle grafts may be needed. At the time of closure, the surgeon frequently is faced with a most difficult decision as to whether or not simple undermining will permit primary closure and healing.

The number of patients treated by any of the methods of delayed bone grafting is insufficient to permit the forming of any conclusions as to the relative merits of the various procedures. It is felt, however, that the most conservative choice would be that of primary saucerization, packing the wound for several weeks, application of split skin grafts to the cavity and then, later, after a period of observation, excision of the skin graft, bone grafting, and primary closure. Some of these patients are satisfied to go about with craters covered with skin grafts, and do not desire obliterative procedures. Frequently, however, maceration of the skin occurs in the cavity and chronic drainage occurs because of inadequacy of the blood supply to the skin.

A difficult decision has to be made as to whether to graft the saucerized cavity immediately or to pack the wound open and insert the bone grafts at a later date. The surgeon must take into consideration the amount of infection judged to be present at the time of

operation, the acuteness of the infection, the sensitivity of the infecting organism to antibiotic agents, and the possibility of adequate closure.

Whenever possible, culture should be carried out preoperatively and the sensitivity of the invading organism or organisms to penicillin and other antibiotics should be determined. The value of tests of sensitivity is well illustrated in the case of a patient recently treated and not included in this series. This man had chronic osteomyelitis and nonunion of the upper part of the right femur as a result of an infection after osteotomy. Culture of material from the draining sinus revealed Micrococcus pyogenes (Staphylococcus aureus) resistant to penicillin and to streptomycin. The patient was not able to take sulfonamide drugs. However, the contaminating organism was extremely sensitive to aureomycin. This drug was administered, and the wound was saucerized and packed open. After 3 weeks, the granulation tissue was curetted out. The defect was packed with chips from the ilium and primary closure was carried out with apparent success to date.

A light cast or posterior molded splint was used in a few of the cases, but immobilization was not considered necessary in those cases in which motion of the extremity did not jeopardize continuity of the closure and in which there was no danger of spontaneous fracture as a result of extensive saucerization. It seems well to keep a drain in the wound until the primary hematoma has been evacuated, since a fifth of the 36 patients in this series had primary postoperative serosanguineous drainage, whether a drain had been inserted or not. In several cases it was felt that a portion of the covering skin was lost because of pressure and elevation from the underlying vascular bed by the primary hematoma.

Generalizing as to the suspected causes of failures in the cases under consideration we conclude that organisms, such as Pseudomonas, Proteus vulgaris, and Escherichia coli, which were insensitive to the therapeutic agent employed or intolerance of the patient to it plays a large role. Inaccessible cavities and cavities in juxtaposition to joint cartilage incline to failure. Inadequate coverage with skin and insufficient early drainage of the stagnant hematoma may lead to delayed success, if not to failure.

SUMMARY AND CONCLUSIONS

An attempt has been made to add to knowledge of the results obtained by free bone grafting after radical saucerization in cases of chronic hematogenous osteomyelitis. It appears that more rapid and more nearly permanent healing may be obtained by this method of treatment than by others. The study is made of 36 cases of chronic hematogenous osteomyelitis in which free bone grafting after saucerization was employed at the Mayo Clinic prior to January, 1951.

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CANCER OF THE STOMACH

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IN referring to biography as his favorite division of literature, Dr. Samuel Johnson (5) remarked that the events in the life of almost any individual, if minutely observed and faithfully recorded, will be of interest and service to others since all human beings are essentially one, with the same hopes, fears, and desires and hence they can profit from the mistakes and triumphs of their fellowmen even though they may be greatly separated by time and distance. One of his finest apothegms is: "All knowledge is of itself of some value. There is nothing so minute or inconsiderable that I would not rather know it than not." If Dr. Johnson's theories may be applied to hospitals and clinics as well as to men and women, then the experience of a single, large department of surgery with a common malady, such as cancer of the stomach, if critically analyzed and recorded in exact detail, should be of interest and possibly of value to others because of the fundamental underlying and only slightly varying pattern of this disease. It is only by continued, diligent study and the realization of the occasional triumphs and successes but, more importantly, of the frequent disappointments and failures that progress is made. With these thoughts in mind the present summary was prepared in order that the results herein recorded may be available for comparison with those which have been reported from other clinics and also with new reports which may appear in the future.

From 1934 to 1946 inclusive, 1,264 patients with cancer of the stomach were seen at the University Hospital. The term cancer is here used in its broadest sense and thus includes not only carcinoma but also sarcoma and lymphoblastoma of the stomach. The latter two groups were small when compared with the number of cases of carcinoma. In cases acceptable for study the diagnosis was based upon findings at operation, autopsy, and biopsy or upon convincing clinical evidence which usually included one or more roentgenologic studies as well as, not infrequently, endoscopic examination. The disposition of these cases is shown in Table I. For certain comparisons the 13 year period has been divided into two approximately equal halves, period I from 1934 to 1940 inclusive, and period II from 1941 to 1946 inclusive. While the total number of patients was approximately the same in these two periods, it will be noted that in period II there was a definite increase in the number of patients for whom some type of operative treatment was carried out but when the resectability for the two periods is compared the difference was less than 1 per cent. Four hundred fifty-seven patients had definitive surgical procedures designed to extirpate the primary tumor by some type of gastric resection or by excision. It is with this latter group of 457 patients that this study is chiefly concerned.

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GENERAL INFORMATION

The series comprised 351 men (76.8 per cent) and 106 women (23.2 per cent), a ratio of 3 to 1. There were 65 deaths among the male patients (18.5 per cent) and 18 deaths in the female group (17.0 per cent). The slightly higher death rate for men is probably due to the fact that more of the ultraradical procedures and new procedures, the techniques of which were being developed, were employed in treating male patients. The age incidence may be summarized by noting that 51.4 per cent of the patients were between 40 and 70 years old, 67.4 per cent between 50 and 70, while 84.7 per cent were in the 40 to 70 year range. Adopting an arbitrary classification consisting of three categories, 17 patients were found to be in the younger group, i.e., under 40; 348 in the so-called "cancer age," 40 to 65; while 92 were over 65 years of age. The operative

TABLE I.—CLINICAL MATERIAL AND DISPOSITION OF CASES

	1934–1946		1934–1940		1941–1946	
	No.	Per cent	No.	Per cent	No.	Per cent
Total cases seen in hospital	1,264		609		655	
No operation (refused or not advised)	507	40.1	274	45	233	35.6
Exploration only or lesser palliative procedures	300	23.7	116	19.1	184	28.1
Definitive operations—resection or excision	457	36.2	219	35.9	238	36.3

mortality for these three groups was 23.5 per cent, 17.5 per cent, and 19.6 per cent respectively. These mortality rates probably are not of great comparative value since the number of patients in the first group is so small. Table II lists the several types of operative procedures accompanied by the associated mortality rates. The terms used in the description of operative procedures have been adapted from Welch. Distal resection refers to the conventional subtotal or partial gastrectomy usually with gastrojejunostomy. Proximal subtotal resection, synonymous with cardiectomy or esophagocardiectomy, indicates the removal of the upper portion of the stomach and lower esophagus with reconstruction by esophagogastrostomy. Both proximal gastric resection by the transthoracic route or by an abdominothoracic approach and also total gastrectomy were new procedures which were introduced during the years 1934 to 1946, and this fact accounts for the relatively high mortality rate for these procedures. It is interesting to note that Scott and Longmire reported a similar high mortality for the early cases of proximal resection at the Johns Hopkins Hospital. There were 3 deaths in 8 resections or a mortality of 37 per cent. That the mortality of these procedures is no longer forbiddingly high is attested to by the fact that for esophagocardiectomy Sweet reported an overall mortality rate of 11.6 per cent in 147 cases and of only 8.9 per cent for 101 cases operated on since 1945. Marshall recorded 8 deaths in the last 87 cases of total gastrectomy performed at the Lahey Clinic, or a mortality of 9.2 per cent. This is in striking contrast to a mortality of 30 per cent which was reported for the first group of 84 patients who had this operation. Wangensteen had the very low mortality rate of only 3.5 per cent in 28 cases of total gastrectomy.

TABLE II.—DISTRIBUTION OF 457 CASES ACCORDING TO TYPE OF OPERATION WITH MORTALITY RATES

Type of operation	No. cases	No. deaths	Per cent
Local excision	6	1	16.7
Proximal resection	27	11	40.7
Distal resection	363	57	15.7
Total gastrectomy	61	14	22.9

Overall mortality, 18.1 per cent

The 6 cases in which a local excision only was performed were instances of either gastric polyps or small intramural lesions thought to be benign tumors until later microscopic studies disclosed evidence to the contrary.

The overall operative mortality was 18.1 per cent and during the 12 year period it fell from 21.5 per cent for period I (1934 to 1940) to 15.1 per cent for period II (1940 to 1946) in spite of the greater number of new and more radical procedures during the later years. For total gastrectomy the mortality dropped from 33.3 per cent to 21.2 per cent during the same periods. No proximal resections were performed prior to 1941. Table III delineates the distribution of cases according to the type of operation as well as the number of operative deaths per year. Table IV lists the lesions according to a histopathologic classification with the corresponding mortality rates and also correlates them with the type of operation which was performed.

Table V outlines in a convenient manner the duration of symptoms prior to entry, first, for the entire group of 457 cases and, secondly, for the cases seen during the first and the second halves of the study period. The similarity in the latter two lists is disappointing although there is a perceptible improvement since, in period II, there is a 5 per cent increase in the number of patients

TABLE III.—DISTRIBUTION OF CASES BY YEAR IN 457 DEFINITIVE OPERATIONS

				Definitive operations							
Year	Total No.	No. op. deaths	Per cent mortality	Distal resect.	No. op. deaths	Total gastrec.	No. op. deaths	Prox. resect.	No. op. deaths	No. excisions	No. op. deaths
1934	27	5	18.5	25	5	0	0	0	0	2	0
1935	19	8	42.1	19	8	0	0	0	0	0	0
1936	23	3	13.0	22	3	0	0	0	0	1	0
1937	35	10	28.6	32	0	2	1	0	0	1	1
1938	36	8	22.2	34	0	2	0	0	0	0	0
1939	30	8	26.6	29	7	1	1	0	0	0	0
1940	49	5	10.2	43	4	4	1	0	0	2	0
1941	39	2	5.1	36	1	1	0	2	1	0	0
1942	61	11	18.0	37	4	14	2	10	5	0	0
1943	25	4	16.0	18	1	4	0	3	3	0	0
1944	34	5	14.7	25	2	8	3	1	0	0	0
1945	37	6	16.2	22	3	9	3	6	0	0	0
1946	42	8	19.0	21	3	16	3	5	2	0	0

who were seen within 6 months following the onset of symptoms.

GENERAL AND SURGICAL PATHOLOGY

There were 83 hospital deaths following all types of definitive operation, a mortality rate of 18.1 per cent. In Table VI these 83 fatal cases have been grouped according to the type of operation, the cause of death, and the confirmation of the findings by autopsy when autopsies were performed (55 cases). The high mortality of total gastrectomy and of proximal gastric resection is accounted for chiefly by leakage at the anastomosis, an anastomosis in which the esophagus is involved and in which the hazards of suture are well known.

Of the 83 cases in which death occurred in the hospital, autopsies were performed in 55. Particular attention was given to the matter of residual neoplasm demonstrated at autopsy. Table VII summarizes this evidence. It will be noted that in 34 cases no residual neoplasm was detected microscopically even on the most searching study. In 3 cases residual carcinoma was found and removal at operation theoretically would have been feasible had the procedure been more extensive. These 3 patients had all been treated by distal resection and the residual neoplasm was found in the lymph glands adjacent to the remaining gastric pouch. Theoretically, total gastrectomy could have eliminated these positive lymph nodes. In 5 cases residual carcinoma was found and in retrospect removal was remotely possible had the original operation been more radical. The involved tissues are listed and while a more extensive operation might have been successful this is very problematical. Because of the position and distribution of the positive nodes, it would have been exceedingly difficult or impossible to recognize them at the time of operation and accordingly to plan and execute a suitable procedure. Even though feasible this necessarily would

TABLE IV.—TYPE OF OPERATION ACCORDING TO LESION IN 457 CASES

Lesion	No. deaths	Mortality per cent	Operative procedure	No. cases
Carcinoma 443	80	18.0	Distal resection	352
			Total gastrectomy	59
			Proximal resection	27
			Excision	5
Lympho-blastoma 12	3	25.0	Total gastrectomy	2
			Distal resection	10
Sarcoma 2	0	0	Local excision	1
			Distal resection	1
Ulcer-cancer 40	4	10.0	Distal resection	35
			Total gastrectomy	5

TABLE V.—DURATION OF SYMPTOMS OF CANCER OF THE STOMACH PRIOR TO HOSPITAL ENTRY IN 457 CASES

Duration	Entire group, No. 457	Per cent	Period I, 219 1934–1940 (incl.)	Per cent	Period II, 238 1941–1946 (incl.)	Per cent
None	5	1.1	3	1.4	2	0.8
Less than 2 wks.	3	0.6	1	0.4	2	0.8
2 wks. to 1 mo.	4	0.9 38.0	1	0.4 35.6	3	1.3 40.4
1–2 mo.	22	4.8 64.9	8	3.6 63.1	14	5.8 67.0
2–4 mo.	65	14.2 78.9	30	13.8 79.6	35	14.8 78.7
4–6 mo.	75	16.4	35	16.0	40	16.9
6–12 mo.	123	26.9	60	27.5	63	26.6
12–18 mo.	64	14.0	36	16.5	28	11.7
18–24 mo.	14	3.1	7	3.1	7	3.0
2–2½ yr.	35	7.7	16	7.4	19	7.9
2½–3 yr.	6	1.3	4	1.8	2	0.8
3–5 yr.	30	6.6	14	6.3	16	6.7
5–10 yr.	10	2.2	4	1.8	6	2.5
Over 10 yr.	1	0.2	0	0	1	0.4

have been an operation of great magnitude. In 13 cases residual carcinoma was found and removal at the time of the original operation by any type of procedure would have been quite impossible. For the most part, the residual neoplasm occurred in the form of distant metastases and, moreover, in most instances the metastatic lesions were so small and in such bizarre locations that they could not have been detected during life by any methods of examination now available. Judging from the postmortem findings in these 55 cases it would seem that total, rather than partial, gastrectomy could have theoretically achieved a better result in only 3 cases. To have subjected all patients to complete gastrectomy with its higher operative mortality and morbidity as well as the high incidence of post gastrectomy symptoms, possibly to improve the results in not over 5 per cent of the cases would scarcely seem justifiable.

Eleven patients returned to the hospital some time after operation and subsequently died in the hospital, and autopsy examinations were made. In 8 cases an extensive abdominal carcinomatosis was encountered. The extent of the disease was so marked that it was impossible to determine whether the origin was at the operative site, in the gastric remnant, in regional or peripancreatic lymph nodes, or elsewhere. In only 1 case was it possible to identify the area of recurrence. This was found to be in the duodenal stump and the head of the pancreas but already hepatic metastases had occurred. In 2 cases no residual carcinoma was encountered. One patient had re-entered the hospital because of a new primary carcinoma of the rectum 7 years after the original gastrectomy. He was treated by a Miles' combined abdominoperineal resection but died of intestinal obstruction during the postoperative period. The second patient returned 8 months after the gastric resection with a new primary neoplasm, an epidermoid carcinoma of the esophagus which had progressed to the stage of perforation with the formation of a tracheoesophageal fistula.

Data have been assembled based on the examination of the surgical specimens concerning (1) involvement of regional lymph nodes by neoplasm, (2) extension of the neoplasm through all layers of the gastric wall with subsequent invasion of the adjacent fat or connective tissue (mesenteries and omenta), and (3) cases exhibiting a combination of these two modes of spread. Table VIII shows the occurrence of lymph node involvement in the 443 cases of carcinoma,

TABLE VI.—POSTOPERATIVE DEATHS (83)

Cause of death	No. cases with autopsy	No. cases without autopsy
Distal resections—57		
Dehiscence of duodenal stump	7	1
Leak at anastomosis	8	
Peritonitis, no leaks	6	
Pneumonia	2	7
Pulmonary embolism	3	1
Peritonitis, cause undetermined		5
Cardiovascular accident		5
Cardiac failure	2	
Hemoperitoneum	2	
Wound sepsis and dehiscence	1	
Inanition		1
Toxic hepatitis		1
Volvulus of jejunum	1	
Cardiac arrest	1	1
Malfunctioning stoma	1	
Perforation of cecum (obstructive resection of transverse colon)	1	
Total resections—14		
Leak at anastomosis	9	1
Pulmonary embolism	1	
Hemoperitoneum	1	
Peritonitis, no leaks	1	
Pneumonia		1
Proximal resections—11		
Leak at anastomosis	6	
Sepsis, no leaks	2	
Sepsis, probable leak at anastomosis		1
Cardiovascular accident		1
Cancer cachexia		1
Local excision—1		
Lung abscess (postpneumonic)		1

the 12 cases of lymphoblastoma, and the 2 cases of sarcoma, as well as the incidence for the group as a whole.

These data were obtained from the routine preparation and study of the surgical material. In a small selected group of 53 cases detailed studies of the resected specimens for involvement of regional nodes were made in our laboratory by Coller, Kay, and MacIntyre.

TABLE VII.—OPERATIVE DEATH WITH AUTOPSY IN 55

Original operation	No. cases
No residual carcinoma—34	
Total gastrectomy	8
Distal resection	21
Proximal resection	5
Residual carcinoma, removal feasible—3 (Perigastric lymph nodes—remaining gastric pouch)	
Distal resection	3
Residual carcinoma, removal possible—5	
Total gastrectomy, 1	
Distal resection, 4	
Pancreas and peripancreatic lymph nodes	1
Perigastric and peripancreatic lymph nodes	1
Peripancreatic tissue	2
Pancreas, peripancreatic lymph nodes and lymph vessels in remainder of stomach	1
Residual carcinoma, removal impossible—13	
Total gastrectomy, 3	
Distal resection, 7	
Proximal resection, 3	
Lymph nodes, mesentery, ovary	1
Regional lymph nodes, pancreas, peritoneum	1
Lymph nodes, pancreas, bone marrow	1
Lymph nodes, liver	3
Mesentery of small intestine	2
Lymph nodes, thyroid	1
Lymph nodes, lungs, bones	1
Thyroid	1
Mediastinal and retroperitoneal lymph nodes	1
Liver	1

Using the modified Spalteholtz method for clearing specimens described by Gilchrist and David they found positive nodes in 40 cases or 75.5 per cent. They calculated, however, that the actual incidence of nodal involvement for all cases would be 88 per cent.

Involvement of adjacent lymph nodes is only one mode of regional spread which may occur independent of hematogenous or gravitational metastases. The special study of 53 surgical specimens made by Coller, Kay, and MacIntyre revealed infiltration of the neoplasm entirely through the gastric wall with involvement of the serosa in 47 cases or 88.6 per cent. Following complete penetration of the wall further extension is characterized by gross or microscopic invasion of the perigastric adipose or connective tissue (mesenteries and omenta) or contact involvement of adjacent structures. Lymph or blood vessel invasion is then a common accompaniment. In the 457 cases under discussion microscopic studies revealed such extension into the peri-

TABLE VIII.—INCIDENCE OF INVOLVEMENT OF REGIONAL LYMPH NODES IN 457 CASES

Lesion	No. cases	Nodes involved	Per cent	Nodes not involved	Per cent	Unclassified
Carcinoma	443	253	69.7	110	30.3	80
Lymphoblastoma	12	9	90.0	1	10.0	2
Sarcoma	2	0	0	1	100.0	1
Total	457	262	70.0	112	30.0	83

gastric tissues in 154 or 33.7 per cent. In 108 cases (23.6 per cent) both regional lymph node involvement and neoplastic invasion of the perigastric tissues had taken place, while in 84 instances (18.4 per cent) neither mode of spread could be demonstrated.

In 15 cases multivisceral resections were necessitated either because of actual contact involvement of adjacent structures or by subacute inflammatory fixation indistinguishable at the time of operation. The organs secondarily resected were: transverse colon 10; pancreas (tail) 4; and spleen 1. The latter case was the only one in which actual neoplastic involvement of the spleen was demonstrated although incidental splenectomy was frequently performed in order to expedite high resections.

PALLIATIVE RESECTIONS

In 31 of the 374 patients who survived operation the procedure was classified by the operating surgeon as one for palliation only. In this group there were 27 cases of distal resection, 2 of total gastrectomy, and 2 of cardiectomy. The findings which precluded any chance for cure were: (1) hepatic metastases, (2) early peritoneal seeding, (3) presence of a rectal shelf, (4) nonremovable contact involvement, for example, abdominal wall, liver, pancreas, and large blood vessels, and (5) early pulmonary metastases as suggested on roentgen examination. Table IX outlines the results of treatment in these cases. The longest survival period was 2½ years. Approximately one half of the patients died during the first 6 months and three fourths of them were dead by the end of the first year. While this record for length of life following operation is not especially impressive or particularly encouraging, it is, nevertheless, true that distressing symptoms, such as those of pyloric obstruction or severe anemia from blood loss may often be alleviated without undue risk by a palliative distal resection. It is our opinion that total gastrectomy is not a satisfactory procedure when palliation only is possible. The slightly higher mortality and morbidity are at present scarcely important factors. However, following complete gastrectomy most patients present complicated problems in feeding and nutrition. If other difficulties resulting from early recurrence are added to these, such procedures fail to palliate and serve merely to prolong a miserable existence. With the mortality for proximal resection now having been reduced to a very reasonable level, this procedure may on many occasions very properly be employed for palliation. It is truly remarkable how well the function of deglutition is restored following the resection of a stenosing lesion at the cardioesophageal junction and even though the benefit may be but temporary it is worth while, especially since no other satisfactory method for the relief of this severe type of dysphagia exists.

TABLE IX.—PALLIATIVE RESECTIONS IN 31 CASES, FOLLOW-UP DATA

Survival period months	No. of deaths per period	Cumulative No.	Per cent dead
0– 6	15	15	48.4
6–12	8	23	74.2
12–18	4	27	87.1
18–24	1	28	90.3
2–2½ yr.	3	31	100.0

Longest survival 2½ yr.

RESECTIONS FOR CURE

In the opinion of the operator, in the remaining 343 cases, resection afforded a chance for cure. In this group of cases a careful follow-up study has been conducted and data have been obtained regarding all patients with 1 exception. Since no information is available concerning this 1 man, he is classified as having died within 6 months, the lowest category in our survival tabulations. All other patients have been followed until the time of death or, if still living, to the

anniversary date of their operation in 1951 (the follow-up year). Thus, all living patients have been followed for a minimum of 5 years, and many treated in the early years of the study period have been followed for a considerably longer time, for example, 10 or even 15 years. Five year survival has been used as the basis for evaluation and comparison for the most part, although the long term survivals are discussed separately in a later section. No attempt has been made to distinguish between 5 year survivals and 5 year clinical cures. Actually most patients who survive for 5 years are clinically cured, although in an occasional instance recurrence may be observed many years later. Also, no distinction has been made between deaths under 5 years due to intercurrent disease and those due to recurrence. Such distinctions are often difficult or impossible to make and hence tend to confuse the interpretation of the remaining data. Accordingly, for the major part of this study bar diagrams have been used to depict 5 year survivals recorded at yearly intervals. For some of the smaller groups simple tabulations are employed.

Figure 1 presents certain general information. It illustrates the course of two groups of patients by showing (1) the overall picture, i.e., 5 year survival for the entire group, which consists of all operations for all lesions, and (2) the results obtained from the most common surgical procedure for the most common lesion, in other words, distal resection for carcinoma of the stomach. It will be noted that the two curves are nearly identical. The slightly inferior showing for the entire group appears to be due to the short postoperative life span following some of the newer and more radical procedures, such as, proximal resection and particularly total gastrectomy. The 5 year survival rate of 29.0 per cent for the distal resections for carcinoma is in close agreement with other reported series. Figure 2 depicts the 5 year survivals recorded by year for the early and the more recent groups of cases (1934 to 1940 and 1941 to 1946). Contrary to our expectations there were fewer 5 year survivals recorded in period II than in period I.

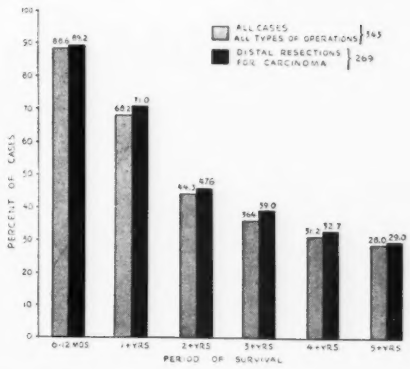

Fig. 1. Bar diagram showing the 5 year survival rate in cancer of the stomach recorded at yearly intervals for all cases with all types of operation, and in contrast similar data for the operation most commonly performed for the most common lesion, distal resection for carcinoma.

This again can be explained by the increase in the number of the more radical procedures, whereby resectability may be extended at the expense of lowering the 5 year curability. In many of these borderline cases the short life span following operation is disappointing. When these results are included in the overall picture, they tend to worsen rather than to improve the record. Moreover, with the advent of the antibiotics and other modern adjuvants in treatment, in period II more patients with advanced lesions were enabled to survive operation but failed to survive for 5 years.

Figure 3 shows comparative 5 year survival curves for the two sexes. The percentage of survivals recorded yearly for 5 years indicates that male patients had a slightly better chance for 5 year survival than females. No ready explanation for this is at hand.

Figure 4 reveals the influence of lymph node involvement on survival. It limns the 5 year survivals of (a) the group with positive nodes, (b) the group with negative nodes, and (c) the entire group consisting of those patients with positive nodes, those with negative nodes, and also the small group concerning which no data regarding lymph nodes were available. The unfavorable effect of nodal involvement on 5 year survival is clearly shown, as well as the con-

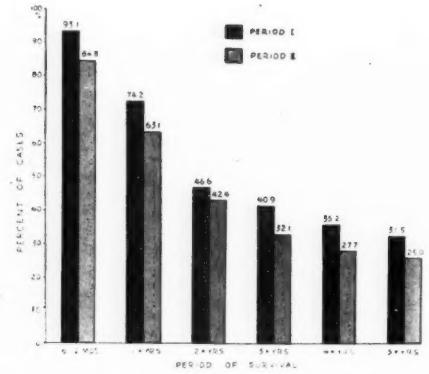

Fig. 2. Bar diagram showing comparative 5 year survival rates in cancer of the stomach for period I (1934 to 1940) (159 cases) and period II (1941 to 1946) (184 cases).

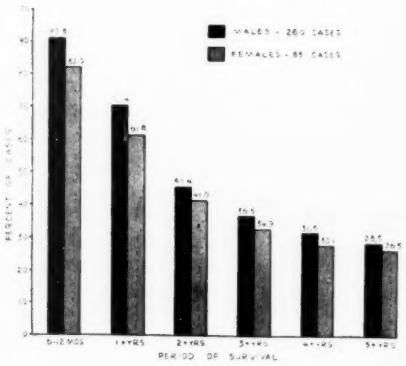

Fig. 3. Bar diagram showing comparative 5 year survival rates in cancer of the stomach for male and female patients.

siderably improved prognosis in cases in which the nodes were uninvolved. It is evident that the more carefully the surgical material is examined the higher will be the incidence of positive nodes. However, in those cases in which no involved nodes can be found on the most meticulous examination the better will be the prognosis.

Disregarding for the moment the factors of lymph node involvement, sex, and age, Figure 5 depicts the influence of adnexal tissue involvement upon 5 year survival. The effect is not unlike that of lymph node involvement and, therefore, it is of equivalent importance in estimating the prognosis in a given case. Figure 6 portrays graphically the course of two contrasting groups of cases, one in which both lymph nodes and adnexal tissues were involved and one in which both of these structures were negative. In the 72 cases of dual involvement the 5 year curability was only approximately one-half that of the 5 year survival rate when nodal involvement or adnexal involvement was considered alone.

Certain other variables are of interest as they affect prognosis. These are the age of the patient, the type of operative procedure, and the histopathologic type of lesion. They are summarized in Tables X, XI, and XII. Table X presents data concerning 5 year survival according to the three aforementioned age groups. It will be noted that essentially no difference was found between the "cancer age" group and the elderly group over 65. The lower percentage of 5 year survivals shown for the younger group is probably not of great significance. In this group the number of patients is so small that it is doubtful if the results can be regarded as indicative of the response of all patients under 40 to treatment.

Table XI epitomizes the 5 year survivals according to the type of operation originally performed. It is of interest that the number of patients who survived for 5 years following a resection for cure was almost 30 per cent regardless of whether a distal or a proximal partial resection was performed but that for total gastrectomy the number of 5 year survivals was only 6.7 per cent. This reflects the earlier attitude concerning total gastrectomy, i.e., in other words, that it should be employed only for advanced lesions. Today, with proper and more intelligent selection of earlier cases for this operation the results of complete gastrectomy in the future should not only be better but, moreover, the end results of treatment of all gastric cancer should be favorably influenced. The small group of cases of local excision scarcely merits comment since (1) it is not a recognized form of treatment for any type of gastric cancer, (2) the lesions for which it was

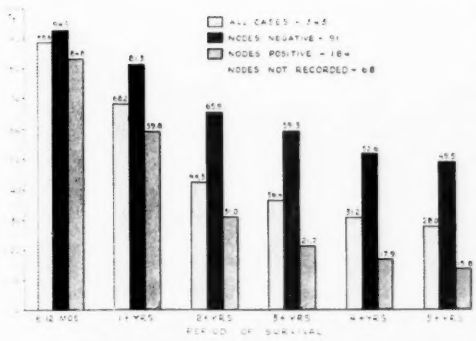

Fig. 4. Bar diagram showing influence of metastasis to regional lymph nodes upon 5 year survival.

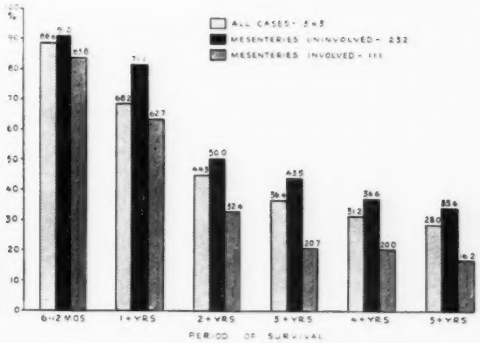

Fig. 5. Bar diagram showing influence of invasion of perigastric tissues by neoplasm upon 5 year survival.

used were all atypical or unique and no generalizations can be drawn, and (3) the group is much too small to be significant. The 60 per cent 5 year survival rate in no way endorses it as an acceptable form of treatment for small lesions including most gastric polyps.

LYMPHOBLASTOMA AND SARCOMA

Table XII presents the results with reference to 5 year survival of the three forms of cancer according to histopathologic classification. The number of 5 year survivals in the carcinoma group is slightly less than that for the group as a whole and this is explained by the unusually good record for the lymphoblastoma and sarcoma cases, although in the latter two groups the number of cases is admittedly small.

Lymphoblastoma. Table XIII gives the duration of symptoms prior to admission for the group of 12 cases of lymphoblastoma. When compared with Table III the longer delay from onset of symptoms to the time of hospital entry would indicate a more insidious onset and a more gradual progress of the disease. Four patients among the 9 who had successful operations for lymphoblastoma have died, having survived for 6 months, 7 months, 4 years 2 months, and 6 years 10 months, respectively. Recurrent disease was responsible for death in 3 patients while the cause of death in the remaining case is not known. The 5 patients living at the present time have survived for periods ranging from nearly 7 to over 10 years. In none of these living patients is recurrence suspected. Two of these patients exhibited exceptionally early lesions and the diagnosis was made only upon microscopic examination of the surgical specimen after resection had been performed for a roentgenologically demonstrated gastric ulcer. A third patient had a relatively small prepyloric lesion clinically believed to be antral gastritis but resection was advised because of the severe symptoms and the possibility of carcinoma. In the group of 9 patients who survived operation prophylactic x-ray therapy over the abdominal area was administered in 5 and omitted in 4. In 1 of these latter cases when recurrence took place x-ray treatment was employed therapeutically but without noticeable effect. We believe that following gastrectomy for lymphoblastoma prophylactic roentgen treatment should be administered except in the case of very early lesions. While the results in this small group of cases are gratifying, especially when viewed in contrast with the carcinoma group, it is our candid opinion that in general the results of treatment in lymphoblastoma are little if any better than those obtained in gastric carcinoma.

Sarcoma. There were 2 cases of gastric sarcoma. One patient had a small tumor situated in the anterior wall of the stomach which was accidentally discovered at the

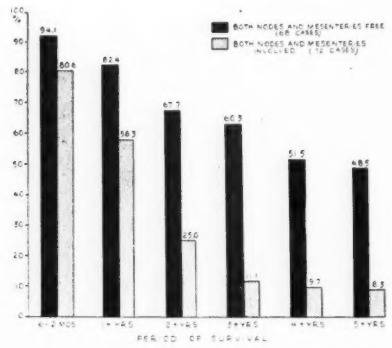

Fig. 6. Bar diagram showing effect of involvement of both regional lymph nodes and of perigastric adnexal tissues upon 5 year survival, and in contrast the course of patients in whom neither of these tissues were involved.

time of a laparotomy for cholelithiasis. It was excised locally. This patient, a woman 64 years of age, survived 7 years and 6 months following operation. Whether or not death was due to recurrence is problematical. The second patient, a 51 year old man, had a fairly large lesion occupying the lower one third of the stomach which caused exsanguinating hemorrhages and which was treated by a distal resection. Microscopic examination showed it to be a neurogenic sarcoma. He died 8 years and 2 months after operation without evidence of recurrence.

ULCER-CANCER

Microscopic examination of the 457 surgical specimens provided adequate data to justify the diagnosis of ulcer-cancer in 40 cases, an incidence of 8.8 per cent. The diagnosis of ulcer-cancer denotes a lesion in which there is histological evidence of an antecedent benign gastric ulcer with a superimposed or coexistent cancer. This diagnosis of ulcer-cancer was made only on the basis of certain rules formulated some years ago by the late Professor A. S. Warthin. These criteria may be epitomized as follows: (1) there must be convincing evidence of an older benign ulcer with the characteristic induration or cicatricial fibrosis which extends through the stomach wall and also the usual associated sclerosis of blood vessels, (2) the greater part of this cicatrix is to be free from neoplastic infiltrations, (3) the neoplasm must be in a relatively early stage of development and limited to the borders or surface of the ulcer, (4) the neoplasm must infiltrate the ulcer scar to only a slight extent so that there can be no doubt that the fibrosis is the result of the healing of an older ulcerative process and not secondary to the cancer. Table XIII lists the duration of symptoms for the 40 ulcer-cancer cases and for comparison the same for the 12 cases of lymphoblastoma. The histories of these two small subgroups are quite similar and it will be noted that in both groups approximately only 50 per cent of the patients were seen within the first 12 months of onset of symptoms in contrast with about 65 per cent when the group was considered as a whole.

Examination of the 40 resected specimens revealed positive lymph nodes in only 56.3 per cent compared with 70 per cent noted in the entire group of 457 cases. There were 4 postoperative deaths among the 40 cases (35 distal resections and 5 total gastrectomies) or an operative mortality of 10 per cent. Of the 36 patients who survived, 22 or 61.1 per cent lived less than 5 years and 14 or 38.9 per cent survived 5 or more years. The 5 year survival rate of 35 per cent, in-

TABLE X.—SURVIVAL ACCORDING TO 3 AGE GROUPS

Age, years	Total No. cases	Lived 0–5 years		Lived 5 yr. or more	
		No. cases	Per cent	No. cases	Per cent
Under 40	13	10	76.9	3	23.1
40–65 incl.	266	191	71.8	75	28.2
Over 65	64	46	71.9	18	28.1

TABLE XI.—FIVE YEAR SURVIVAL ACCORDING TO TYPE OF OPERATION IN 343 CASES

Type of operation	Total No. cases	Lived 0–5 yr.		Lived 5 yr. or more	
		No. cases	Per cent	No. cases	Per cent
Distal resection	279	193	69.2	86	30.8
Proximal resection	14	10	71.4	4	28.6
Total gastrectomy	45	42	93.3	3	6.7
Excision	5	2	40.0	3	60.0

cluding operative deaths, or 39 per cent when postoperative deaths are excluded, is of interest and, when compared with the figures of 28 per cent for all cases and all operations or 29 per cent for distal resections for all carcinomas, it is evident that this is a considerably more favorable group of cases for treatment and it should make mandatory surgical intervention in gastric ulcers which do not show prompt and continued satisfactory response to medical therapy. In approximately one half of these 40 cases at the time of operation the ulcerating gastric lesion had all of the gross appearances and characteristics of a benign ulcer, and malignancy was discovered only on microscopic examination. In the remaining half the neoplasm was already sufficiently advanced to permit a correct gross diagnosis of cancer.

LONG TERM SURVIVALS

Ninety-six patients or 28.0 per cent of the 343 survived for 5 or more years after a successful operation for cure. The fate of all of these patients has been determined. Figure 7 diagrams the number of survivals at 7, 10, 12, and 15 years following operation. The percentages are derived by dividing the number of patients who survived the requisite number of years by the number who theoretically could have lived that long as computed from the date of operation. It will be noted that after the fifth year the curve begins to flatten since death from recurrence after the fifth year is relatively rare. Moreover, considering the age of the patients at the time of operation, after the lapse of 5 years life is usually terminated by intercurrent disease such as one of the degenerative disorders, although infection, trauma, or pos-

TABLE XII.—FIVE YEAR SURVIVAL ACCORDING TO TYPE OF LESIONS IN 343 CASES

Lesion	Total No. cases	Lived 0–5 yr.		Lived 5 yr. or more	
		No. cases	Per cent	No. cases	Per cent
Carcinoma	332	244	73.5	88	26.5
Lymphoblastoma	9	3	33.3	6	66.7
Sarcoma	2	0	0	2	100.0

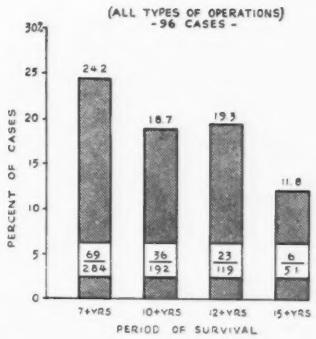

Fig. 7. Bar diagram showing the course of 96 patients with all types of operation who survived more than 5 years.

sibly a second neoplasm, appear not infrequently as the cause of death.

In an attempt to identify any common factors in this group of patients who survived for unusually long periods, some of the data previously considered, such as sex, lymph node involvement, and adnexal tissue involvement, both singly and in combination, are given for this particular group. The sex ratio remains the same, as for the group as a whole, in other words, a predom-

TABLE XIII.—DURATION OF SYMPTOMS PRIOR TO HOSPITAL ENTRY IN CASES OF ULCER-CANCER AND LYMPHOBLASTOMA

Duration	Ulcer-cancer—40 cases			Lymphoblastoma —12 cases	
	No.	Per cent	Per cent	No.	Per cent
None		↑	↑		↑
Less than 2 wks.					
2 wks. to 1 mo.	1				
1–2 mo.	1	30			
2–4 mo.	5		45	1	50
4–6 mo.	5	↓			
6–12 mo.	6		↓	5	↓
12–18 mo.	1			1	
18–24 mo.	2				
2–2½ yr.	7			1	
2½–3 yr.	1				
3–5 yr.	7			1	
5–10 yr.	4			3	
Over 10 yr.	0			0	

inance of males by the ratio of 3:1. The ratio of cases with negative to positive lymph nodes for this group is 6 to 4 in contrast with the 3:7 ratio noted for the entire group of 457 cases. Even more striking is the ratio of absence of adnexal involvement of approximately 5:1 in contrast to a 2:1 ratio for the entire group. The incidence of cases with both negative nodes and adnexae in this group was 37.7 per cent compared with 18.4 per cent for the group as a whole and the incidence of doubly positive findings was 7.7 per cent compared with 23.6 per cent.

Calculated on the basis of the 1,264 patients with gastric carcinoma that were seen, 96 or 7.8 per cent survived for 5 years; 36 or 2.8 per cent for 10 years, and 6 or 0.47 per cent for 15 years. In spite of the introduction of newer and more radical operative procedures and a substantial reduction in operative mortality during period II (1941 to 1946), the overall survival rate was 7.0 per cent compared with 8.2 per cent for period I (1934 to 1940).

SUMMARY

1. During the years 1934 to 1946 inclusive 1,264 patients with gastric cancers were observed and in 457 cases (36.2 per cent) definitive surgical procedures were carried out.

2. The overall operative mortality was 18.1 per cent and was highest for proximal resection (esophagocardiectomy) (40.7 per cent) and next highest for total gastrectomy (22.9 per cent), new procedures which were introduced during this period.

3. From an examination of the autopsy material with reference to residual neoplasm in 55 cases of postoperative death, in only 3 was there evidence that a total gastrectomy, instead of the subtotal resection performed, might have given a better result.

4. Microscopic examination of the specimens removed at operation revealed metastases to the regional lymph nodes in 70 per cent, microscopic or macroscopic invasion of the perigastric adipose or connective tissue in 33.7 per cent, and involvement of both of these tissues in 23.6 per cent.

5. In 31 cases of carcinoma the resections were for palliation only. The longest survival after such an operative procedure was 2½ years. One half of these patients died within 6 months and three fourths within a year. Nonetheless, the relief of bleeding and obstruction often made the procedures worth while.

6. Follow-up data concerning the 343 cases of operation for cure revealed the following: (a) 28 per cent of the patients survived for 5 or more years after operation; (b) males exhibited a slightly higher operative mortality but also a slightly higher 5 year survival rate than did females; (c) there was no convincing evidence that the age of patients at the time of operation affected the prognosis; (d) partial gastrectomy, whether a distal or a proximal resection, resulted in approximately the same number of 5 year survivals, i.e., nearly 30 per cent; (e) only 6.7 per cent of patients who survived total gastrectomy survived for 5 or more years; (f) when involvement of the regional lymph nodes had occurred 16 per cent survived for 5 or more years, whereas, in the group without nodal involvement there were approximately 50 per cent of 5 year survivals; (g) with involvement of the perigastric adipose or connective tissues 16 per cent survived for 5 years and in the absence of such demonstrable involvement 35 per cent were living at the end of 5 years; (h) when both of the modes of spread mentioned had occurred, only 8 per cent of the patients survived for 5 or more years; in the contrasting group when both nodes and adnexal tissues were negative the 5 year survival was approximately 50 per cent.

7. The 5 year curability was higher for operations performed during the first half of the study period than for those performed during the more recent years. This paradox may be explained by: (a) the lower mortality rate in period II whereby more of the advanced cases were enabled to survive operation; (b) the greater number of ultraradical procedures, such as proximal gastric resections, total gastrectomy, and operations involving multiple procedures which increased the radicalism of attack, but in many of which the 5 year survival rate was exceedingly low.

8. Follow-up studies concerning long survival periods calculated on the basis of the number of patients who could have survived the required number of years revealed that 24.2 per cent lived 7 or more years, 18.7 per cent 10 years, 19.3 per cent 12 years, and 11.8 per cent 15 or more years.

9. In 40 cases in which the diagnosis of ulcer-cancer was made by the pathologist, there were 4 operative deaths. Thus, the 5 year curability was 39 per cent if operative deaths are excluded, or 35 per cent when the operative fatalities are taken into consideration.

10. Certain data are presented concerning the small groups of lymphoblastoma (12 cases) and sarcoma (2 cases), but the number of cases is too small to warrant any definite conclusions.

11. The number of 5 year survivals following definitive surgical treatment and based on the total number of patients seen (1,264) was 7.8 per cent.

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COMBINED SURGERY AND IRRADIATION IN THE TREATMENT OF CANCER OF THE CERVICAL STUMP

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THIS paper deals with carcinoma in the retained cervical stump, its mode of lymphatic spread, its best clinical evaluation, and its therapy.

The occurrence of carcinoma as a primary lesion in the cervical stump after subtotal hysterectomy was first mentioned by Chrobak in 1896. Polak in 1921 collected 256 cases of carcinoma of the cervical stump from the literature and this awakened interest in the subject.

INCIDENCE

The incidence of carcinoma of the cervical stump occurring in several series of carcinoma of the cervix is presented in Table I. The average incidence of 4.1 per cent of cervical stump cancer obtains in these large series of carcinoma of the cervix.

The incidence of cancer of the cervical stump following supracervical hysterectomy has been reported as occurring in from 0.45 to 1.0 per cent of the cases as demonstrated in Table II.

LYMPHATIC SPREAD

Poirier in 1890 and Henriksen (14) in 1949 made great contributions to the knowledge of this subject. The latter made careful lymph node dissections of treated and nontreated cancers of the cervix and its stump during necropsy. He separated the lymphatic nodes into primary and secondary groups. The primary group included the parametrial, the ureteral, the hypogastric, the obturator, and the external iliac nodes. The secondary group consisted of the sacral, the common iliac, the inguinal, and the aortic nodes.

The lymphatic spread, from carcinoma of the cervical stump, follows a constant pattern: the parametrium, the nodes of the primary group, and finally the nodes of the secondary group, before extension beyond the pelvis. Figure 1 illustrates each set of nodes that carcinoma of the cervical stump is likely to follow. There are three principal lymphatic pathways along which carcinoma of the cervical stump may travel: (1) from the paracervical plexus and following the course of the uterine artery to the external iliac and obturator nodes, (2) from the paracervical plexus and following the uterine vein posteriorly, terminating in the hypogastric nodes, and (3) through the uterosacral folds on both sides of the rectum, ending in the sacral nodes. In addition, the paracervical lymphatics intercommunicate with the lymph channels leading to the base of the bladder. Thus chronic cervicitis quite often produces cystitis and carcinoma of the cervical stump may find its way into the bladder. The so-called bullous edema seen over the trigone on cystoscopic examination, in a known case of carcinoma of the cervical stump, should always be looked upon as a result of cancer until it is proved otherwise. Besides the lymphatic pathways mentioned this type of carcinoma may spread by continuity, contiguity, and the blood vascular systems.

REGIONAL NODE INVOLVEMENT

To what extent the regional nodes are involved in cancer of the cervical stump is not accurately known. Studies of serial sections of the parametrial tissues obtained at radical operations by Schauta, Kundrat, and Sampson disclose that parametrial involvement connotes glandular involvement in about ½ of the cases, and uninvolved parametria indicate glandular metastases in ⅓ or less. Meigs (17) reported in a group of carefully selected early stage I carcinomas of the cervix, 17 per cent of positive nodes, while 28 per cent of the nodes were positive in early stage II cases. In the advanced stage of the disease 66 per

cent were found to have positive nodes in a recent operative series of 20 patients subjected to pelvic exenteration. Taussig in a larger series of 175 cases of stage II carcinomas of the cervix operated upon, found 26.8 per cent with positive nodes. Taylor found that regional metastases had occurred in about ⅓ of the "operable" cases, and that the incidence of involvement jumped from about 15 per cent in patients in whom the parametria were microscopically free of cancer to 35 to 55 per cent when one or both parametria were directly invaded. The authors have good reason to believe that a very similar incidence of node involvement does obtain in cancer of the cervical stump.

DISTANT METASTASES

Apparently the frequency of distant metastases in cases of carcinoma of the cervical stump is not fully appreciated. Henriksen (14) in 1949 reported a 32.5 per cent incidence of distant metastases in 154 nontreated and 37.8 per cent incidence in 202 treated cases of cervical carcinoma. These findings were verified at autopsy. The liver was the most frequent site of metastases, with the bone, lung, and bowel involved in that order. Behney noted distant metastases in 44 per cent of a series of untreated patients and in 21 per cent of treated patients at autopsy.

OBSTRUCTION OF URETERS

In Henriksen's series 82.8 per cent of the nontreated and 78.6 per cent of the treated cases had evidence of ureteral compression and hydronephrosis. Spence and Hare stated that obstruction of the ureters above the intramural portion, at the site where the ureters entered the broad ligament, was primarily due to parametrial extension of the neoplasm, rather than to the effects of radiation. Cases showing ureteral obstruction have a poor prognosis since they almost invariably terminate in death with the growth unchecked.

SURGERY IN PREFERENCE TO IRRADIATION IN SELECTED CASES

The factors listed in order of their importance favoring surgery over radiation in selected stage I and early stage II cancers of the cervical stump are: (1) prediction of radiation resistant cases by competent cytologists, (2) failure of radiation therapy to deal more successfully with the problem of regional nodes, (3) local recurrence following apparently adequate irradiation, (4) technical difficulties and limitations of radium application to the stumps bearing cancer, (5) stenosis of the upper vagina occurring in some cases, as a complication of external roentgen therapy, making subsequent radium application almost impossible, (6) greater incidence of postradiation complications in cancer of the cervical stump than in treatment of carcinoma of the cervix in the intact uterus, and (7) the success of surgery by Bonney, Taussig, and Meigs.

TABLE I.—INCIDENCE OF CANCER OF THE CERVICAL STUMP

Author	Patients with cancer of cervix	No. of stumps	Percentage of stumps
Von Graff	4,269	176	4.1
Healy and Arneson (11)	2,600	67	2.6
Ward (34)	879	61	6.7
Given	212	8	3.8
Cantril and Buschke	223	14	6.0
Merritt	331	18	5.0
Healy and Frazell (12)	557	13	2.3
Costolow	1,906	102	4.9
Meigs (15)	1,218	26	2.1
Black	234	19	8.1
Raphael and Waterman	432	25	5.7
Total	12,861	529	4.1

1. *Prediction of radiation resistant cases.* To place the surgical approach to carcinoma of the cervical stump or cervix itself upon a scientific basis, Graham has recently undertaken to predict the cases showing no irradiation response. She studied 73 cases of cervical carcinoma by means of the vaginal smear during and immediately after irradiation treatment. She has been able to trace every one of the 73 patients and the prognostic accuracy at the end of 5 years is 75 per cent. Of 37 patients classified as poor responses only 1 is

TABLE II.—INCIDENCE OF CANCER OF THE CERVICAL STUMP AFTER SUBTOTAL HYSTERECTOMIES

Author	Subtotal hysterectomies for benign conditions	No. of cases of cancer of the cervical stump	Percentage
Henriksen (13)	6,550	26	0.45
Pearse	810	8	1.0
Von Graff	7,244	45	0.62
Meigs (15)	1,774	13	0.73

alive at the end of 5 years. Of 36 patients considered to be good responses, 20 are alive, or an absolute prognostic accuracy of 55 per cent. She further indicates that in the majority of good responses the local tumor is cured, while in the majority of poor responses, the local disease is not eradicated. What constitutes good or bad radiation response? If the great majority of the nonmalignant epithelial cells in the vaginal smear showed radiation changes, the case was considered to be a good response, and vice versa. The radiation changes in the benign epithelial cells of the vaginal smears consist of vacuolization of the cytoplasm, increase in size of both nucleus and cytoplasm, appearance of 2 nuclei in a single cell, and nuclear changes such as wrinkling, irregularity of chromatin and of the nuclear border.

Glucksmann and Spear have attempted to quantitate the irradiation response in treatment on biopsies taken from the growing edge of a tumor. If the degenerating and carcinoma cells are plotted against the days of treatment a graph is obtained in which the 2 lines cross, since as the degenerating cells increase the carcinoma cells disappear. In an unfavorable response a graph is obtained in which these 2 lines are parallel. They report an 86 per cent accuracy.

2. *Shortcomings of irradiation in the cure of involved regional nodes.* The actual effect of irradiation upon malignant cells in the lymph nodes consists primarily of fibrosis and perhaps some structural changes in these cells. However, these entrapped cancer cells may break this fibrous tissue barrier early in the postradiation period or after a lapse of 5, 10, or more years. Henriksen (14), in a series of 420 necropsies, studying the lymphatic spread of treated and nontreated cancers of the cervix and of the body of the uterus, concluded that the marked fibrosis and hyalinization usually interpreted as an indication of the effects of prolonged and intensive radiation were also present in over 12 per cent of the nontreated cases. The nodes of 17 per cent of this group, located within the accepted range of the effect of irradiation, exhibited no disturbance of their histological patterns. So far there has been no supporting evidence to demonstrate that irradiation therapy can deliver a lethal dose to these malignant cells in the lymph nodes within the limits of tolerance of the adjacent tissues.

Taussig, Counseller, and Meigs have found that it is impossible to cure patients with this disease by irradiation therapy if the lymph nodes are involved. The claim by many surgeons that present methods of radiation therapy cannot eradicate cancer in the pelvic lymph nodes is not without foundation. It is generally agreed that metastatic cancer in the neck cannot be completely destroyed by external radiation alone, and that such metastases are best treated by radical neck dissection. Since most of the tumors arising in the cervix are epidermoid in nature, it would seem illogical to expect external radiation to accomplish in the pelvic nodes what it cannot do in the neck.

3. *Local recurrence following apparently adequate radiation.* Meigs (17) in 1949 reported a series of 50 patients in whom the radical extraperitoneal lymph node dissection was employed, subsequent to apparently adequate irradiation therapy, when cancer of the cervix was thought to be under full control. However, mistakes have been made in the proper evaluation of the possibilities of local cure for there have been 14 per cent of the cases in which the disease has recurred locally following the pelvic node dissection. Once the growth is adequately and widely excised, the possibility of its local recurrence is eliminated.

4. *Technical difficulties of radium application to the stumps bearing cancer.* The limitations of irradiation therapy and the risk of its causing fistulas both favor surgery. In cervical stump carcinoma the uterine canal is no longer available, and in almost every case the cervical canal is either obliterated or too shallow to permit the introduction of radium. Accordingly, any increase in the paracervical or intravaginal radium dosage in order to compensate for the inability to use intrauterine radium, carries with it the added risk of rectovaginal or vesicovaginal fistulas. Healy and Arneson (11) in 1935 in reporting their poor 5 year salvage of 14 per cent in stump cancer attributed it to the anatomic difficulties and change caused by the absence of the fundus,

as it did not allow the same snug application of the radium, or the same degree of dosage.

5. *Occasional stenosis of upper vagina following external X-ray therapy.* Sandler (26) has clearly indicated that stenosis of the upper vagina may follow external roentgen therapy and, in some cases, subsequent radium treatment has to be modified or abandoned because of this complication. A relatively long interval of about 6 weeks between roentgen and radium therapy tends to increase the frequency with which this stenosis is encountered when radium insertion is attempted. Thus Sandler (27) and Tod at the Holt Radium Institute, Manchester, have advocated the use of radium either before roentgen therapy, or its insertion within 1 to 2 weeks thereafter, in order to prevent narrowing of the upper vagina.

6. *Greater incidence of postradiation complications.* Ward (33) stated that in his experience and that of Behney and Scheffey, the chance of curing cancer of the cervical stump with radium was no less than that in corresponding classes of cervical cancer with the uterus intact. However, Ward admitted that the incidence of vesicovaginal fistula was 150 per cent higher in stump carcinoma than when the uterus is preserved. According to Ward, Behney found fistula three times as often in radium treated as in untreated cases of the stump bearing cancer in his series.

7. *The success of surgery by Bonney, Taussig, Meigs, and others.* In 1905, Wertheim reported a series of 100 cases to a group of English surgeons with a 5 year survival rate of 40 per cent, but a primary mortality rate of 30 per cent. One surgeon in the group who was determined to go ahead with a similar investigation was Dr. Victor Bonney. By 1936 Bonney had performed 500 Wertheim hysterectomies with a 5 year survival rate of 43 per cent. Of the 300 patients with uninvolved nodes, 58 per cent survived 5 years and the initial mortality rate was 10 per cent. Of the 200 patients with involved nodes, 25 per cent survived 5 years, and the initial mortality rate was 20 per cent. In other words, if the disease has spread to the nodes the risk of surgical treatment is twice as great and the results are only half as good as when the nodes are not affected. Thus the presence or absence of node involvement determined during laparotomy is of great prognostic value.

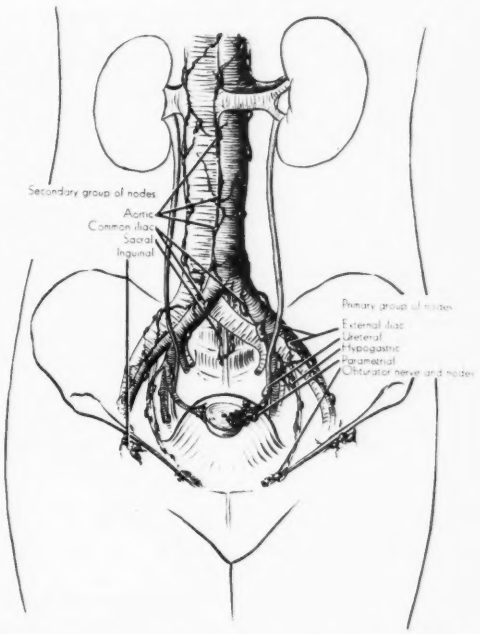

Fig. 1. Lymphatic spread in carcinoma of cervical stump.

Bonney's choice of cases was determined on whether there appeared any chance at all to remove the growth. No preoperative or postoperative radiation was employed in his series. Bonney found his operability rate to be 80 per cent in his private practice and 63 per cent in ward practice. In contrast to these figures, the operability rate for invasive carcinoma of the cervix, as reported by Joseph H. Pratt (24) from Mayo Clinic, was 10 to 15 per cent. The operability rate reported by Morton in his series is 10 per cent and that by Meigs (16) 7 to 10 per cent.

Inspired by the reports of Bonney in England, and Lynch and Morton in California, Meigs performed 100 Wertheim operations with the radical bilateral Taussig pelvic lymphadenectomies in selected good risk stage I and stage II cases without a death. His results have not been duplicated. J. H. Pratt (23) reported 203 radical Wertheim hysterec-

tomies with bilateral dissection of the pelvic nodes at the Mayo Clinic from 1930 through 1950, with the hospital mortality of 4.4 per cent (9 deaths among 203 patients). Since 1943 and through 1950, there were 115 consecutive cases without a hospital death. For many years the main objection against Wertheim hysterectomy was its prohibitive mortality. At present this procedure should not carry any more than 2 to 3 per cent operative mortality when performed by a competent, well trained surgeon.

For many years Taussig advocated pelvic lymphadenectomy as a supplemental procedure to radiation in the treatment of carcinoma of the cervix. Taussig in 1943 reported a 5 year survival rate of 38.6 per cent in early stage II cases of carcinoma of the cervix in whom radical intra-abdominal pelvic lymphadenectomy was performed; in 118 similar cases treated by radiation alone the 5 year survival rate was 22.9 per cent. In other words, Taussig demonstrated a 68 per cent greater salvage if lymph node dissection was added to radiation. His operative mortality was only 2 per cent in a series of 175 cases.

DISCUSSION

Counseller and Meigs believe that the percentage of cases of cancer of the cervix in which surgical treatment is applicable will remain around 20 per cent since 80 per cent of them have extended beyond the confines of the cervix when first seen. Meigs has found that 60 per cent of the patients die with this disease which is mostly confined to the pelvis. This observation, in conjunction with doubtful radiation results upon metastases in the regional nodes, prompted a revived interest in surgery as an adjunct to irradiation therapy in the treatment of cancer of the cervix or its stump.

Obviously the preinvasive carcinoma, "carcinoma in situ" or "intraepithelial carcinoma" of the cervical stump should be treated by vaginal or abdominal cervicectomy. During the child-bearing period even a local wide excision is permissible providing the patient is kept under close and constant supervision. Stage I and stage II radiation resistant cases as soon as they are detected should be subject to radical abdominal cervicectomy combined with the bilateral Taussig pelvic lymphadenectomy. Stage III and stage IV radiation resistant cases (League of Nations classification) and the ones in which radiation therapy has failed to effect a cure, should be considered for pelvic evisceration. Complete pelvic evisceration, as advocated by Brunschwig, should be reserved for cancers of the cervical stump showing extension into bladder or rectum, or pelvic fixation but with the disease still within the confines of the pelvis. In some cases operability can be determined only during abdominal exploration. The author (H.A.Y.) has attended several of these cases while at the Westfield State Sanatorium, Cancer Division, Massachusetts. While the operative technique can be mastered by a well trained surgeon, the postoperative care presents a serious burden upon the resident and nursing staff. Moreover, the idea of "wet colostomy" is not to be lightly dismissed. The authors advocate that complete pelvic evisceration be limited to the institutions that are especially equipped to cope with these problems.

There will still be a considerable percentage of stages I, II, and III radiation-sensitive cancers of the stump which, after the growth is locally controlled by irradiation therapy, should be subjected to bilateral extraperitoneal lymph node dissection. In this way by supplementing radiation with pelvic node excision, one may enhance the 5 year salvage rate of cases showing lymph node involvement. Moreover, the extraperitoneal pelvic node dissection is within capabilities of an average surgeon and can be performed upon poor risk patients without any untoward mortality. Meigs' main objection to the Taussig operation was that the lymph node area about the cervix, i.e., the parametrial and ureteral nodes, and the intervening lymphatics are not completely removed. The operation that would meet this objection was that of Wertheim when performed in conjunction with the radical bilateral Taussig lymphadenectomy. Obviously no final evaluation of the revived Wertheim-Meigs operation or extraperitoneal lymph node dissection can be made until 5 year survival rates are available upon a large series of cases carefully classified by stages.

Heyman at the Radiumhemmet in Stockholm has persistently reported a greater 5 year survival rate in stages III and IV cases than most established clinics in this country. It may be advisable to introduce their exact method of radiation therapy for this disease in the United States in order to ascertain if their results can be duplicated.

THE TERM "WERTHEIM OPERATION"

The authors believe that the term "Wertheim operation" is often used loosely and that accurate definition is necessary, since under this expression some surgeons perform operations which are hardly more than total hysterectomies. Bonney popularized the expression of Wertheim operation in England but he employed a more radical operation with more extensive pelvic lymph node dissection than Wertheim. Meigs does radical panhysterectomy with en block removal of the pelvic nodes from the bifurcation of aorta down to superficial and deep nodes in the groin, and calls it radical total hysterectomy with bilateral dissection of the pelvic lymph nodes. Brunschwig calls attention to this lack of definition which makes the appraisal of the postoperative results difficult. He suggests the term "radical panhysterectomy with en block pelvic node resection" or "with systematic iliac, hypogastric-obturator node excisions" instead of "Wertheim." Certainly any of these descriptive and more accurate designations would appear to be in order.

PALLIATION IN ADVANCED CARCINOMA OF THE CERVICAL STUMP

Sooner or later one has to face the problem of intractable pain, compression of the ureters with secondary infection, or hemorrhage. If it is certain that all pain is limited to one side, then contralateral unilateral chordotomy at the second thoracic level will result in relief of pain with minimum incidence of bladder disturbance. However, it has been our experience that in most cases bilateral anterolateral chordotomy is required, since shortly after the unilateral cutting of spinothalamic fibers the patient begins to complain of pain on the hitherto uninvolved side. Usually in these cases the patient's longevity is found to be much less than 3 months instead of the customary 6 months insisted upon as an indication for chordotomy. The authors assume that in these instances the overwhelming pain on one side masked the less noticeable pain on the other side. The authors urge that unilateral chordotomy be considered earlier in these patients before the intractable pain demoralizes the patient and his family.

Obstruction of the ureters with secondary infection may necessitate some type of decompression operation such as nephrostomy or ureteral transplantation into skin or bowel as a last resort.

The occurrence of vaginal bleeding is a serious omen and may be temporarily controlled by tight vaginal packing or by ligation of hypogastric arteries if it is feasible.

PREVENTION

It is generally agreed that total hysterectomy is the treatment of choice whenever a decision for hysterectomy is rendered. However, general debility, systemic diseases, complicating pelvic inflammatory disease or extensive endometriosis may militate against it. Should subtotal hysterectomy be performed one must make certain prior to the operation that the cervix is not the site of chronic infection or of an incipient carcinoma. Most of all every patient with a retained cervix should be thoroughly instructed as to the necessity of periodic follow-up examinations. Once the patient's confidence is secured, the majority of women are only too willing to co-operate.

SUMMARY

1. The incidence of cancer of the cervical stump and its lymphatic spread has been reviewed.

2. The authors urge a periodic inspection of each retained cervix every 3 months to detect any incipient inflammatory or neoplastic change, for the reasons mentioned.

3. It is now possible from the microscopic tissue studies to predict the effect of radiation in advance.

4. Surgery, as an adjunct to irradiation therapy, should have a wider field of applicability in cancer of the retained cervical stump than in carcinoma of the cervix.

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EXTRACELLULAR FLUID VOLUME IN SURGICAL PATIENTS

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THIS is a presentation of a simple, single injection method for measuring extracellular fluid. After a single intravenous injection of an appropriate substance, one can experimentally calculate the maximal volume of distribution of that substance in the extracellular fluid. Inulin is used, but any similarly behaving substance can be used. Inulin readily passes the capillary membrane; it is not metabolized; it does not enter the cell; and it is all excreted in the urine. It should, therefore, be present in the extracellular fluid for a period of time, and then leave the extracellular fluid to be excreted. Its maximal volume of distribution under basal conditions can be said to represent the total interstitial fluid together with the plasma water. The personnel and equipment needed place this method within the reach of laboratories operating with limited funds at their disposal. While we present only sufficient material to demonstrate the theory, it can be stated that values are repeatable in a given person and have been found to reflect quantitatively many alterations in hydration which one sees in surgical patients.

PROCEDURE OF INVESTIGATION

Immediately after blood and urine samples have been taken, 1,000 milligrams of inulin in 10 cubic centimeters of 0.9 per cent saline diluent are given intravenously to a resting patient who is under water diuresis. Heparinized blood samples are drawn at approximately 15, 30, 40, 50, 60, 70, and 80 minutes, and the exact time is recorded. Total urine samples are taken similarly at about 5, 20, 30, 40, and 70 or 80 minutes, again the exact time being recorded. Inulin determinations are made by Schreiner's resorcinol method with a Coleman Jr. spectrophotometer, and graphs are plotted of the percentage of plasma inulin levels and total urine inulin excretion, each against time as shown in Figures 2 to 7. For the true amounts, a corrected graph to eliminate the error of kidney dead space (renal pelvis and ureters) is drawn through zero time parallel to the original experimental graph. The volume of inulin distribution at various times from 30 to 80 minutes is calculated by dividing the plasma level into the difference between the total amount given and the corrected urinary excretion. This volume of distribution is plotted against time, and a maximal peak occurs at 40 minutes in each case, with the volume of extracellular interstitial fluid given in cubic centimeters.

Six cases done consecutively are presented with complete graphs. The patients were picked to represent as great extremes in body build, weight, age, and disease as were found on our surgical wards.

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LEAN MUSCLE MASS ESTIMATION

From his work on some 5,000 male students, Sheldon has classified the body using three series of digits, each series ranging from 1 to 7. The first digit represents the degree of fat that is predominant. (This more properly is the degree of endomorphy or soft body roundness.) Digit 1 is very lean while 7 is very fat. This classification corresponds to the viscerotonia in a motivation and temperament assessment of people. It is the estimation of fat with which we are concerned.

Since variation in fat from person to person is the greatest normal variable factor encountered, one should correct for this factor by giving percentage values of extracellular fluids as well as many other determinations, such as basal metabolic rate, and possibly body electrolytes.

The specific gravity of the body can be calculated from the expression:

$$S = 1.1094 - 0.0119\,E$$

where S is the specific gravity and E is the

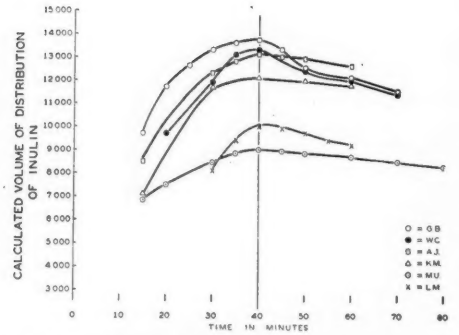

Fig. 1. Volume of inulin distribution plotted against time showing peak at 40 minutes in 6 subjects studied.

TABLE I.—DATA ON 6 PATIENTS

Figure	2	3	4	5	6	7
Name	M.J.	G.B.	A.J.	K.M.	L.M.	W.C.
Sex	F	M	F	F	M	M
Age, years	61	51	62	62	13	31
Weight, kgm.	46.9	75.0	79.0	61.0	53.6	63.7
Specific gravity	1.0975	1.0499	1.0380	1.0618	1.0856	1.0618
Endomorphy rating	1	5	6	4	2	4
Per cent fat	1.6	22.6	29.1	17.0	7.0	16.6
Actual fat, kgm.	.75	16.9	22.9	10.4	3.8	10.6
Fat fluid, mls.	75	1690	2290	1038	380	1060
L.M.M.* kgm.	46.2	58.1	56.0	50.6	49.8	53.1
L.M.M. fluid, mls.	9115	11910	10810	10962	10620	13242
Fluid per cent total weight	19.5	18.1	16.6	16.6	19.8	20.7
Fluid per cent L.M.M.	19.7	20.5	19.3	21.6	21.3	25.0

*L.M.M., lean muscle mass

digit used as an index of the degree of endomorphy.

The percentage of body fat is then estimated from the equation:

$$\text{Percentage fat} = 100\left(\frac{5.548}{S} - 5.044\right)$$

and the actual fat calculated in kilograms. This subtracted from the total weight of a person gives his lean muscle mass. Lean muscle mass is used to connote muscle and muscle interstitial extracellular water, bone, and connective tissue, in contradistinction to fatty tissue per se.

Approximately one tenth of fat weight is probably extracellular fluid, and this subtracted from total extracellular fluid gives the "lean muscle mass extracellular fluid" which can be expressed as a percentage of his lean muscle mass.

The accuracy of this fat estimation depends upon the ability to evaluate the first component of the somatotype. This the Bethesda (1) group found could be done with a little practice to within approximately 3 per cent error in one third of the cases and less in the remaining cases, as compared to a water immersion technique corrected for residual lung air. This group also assumes the generally given value of "fat water" as one tenth of its weight.

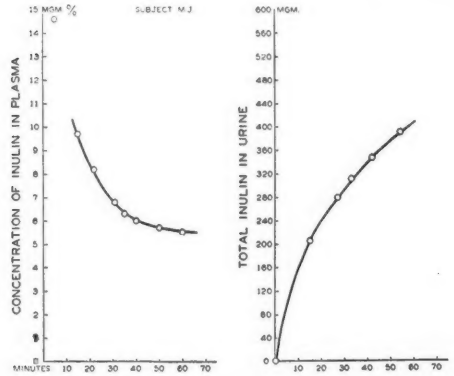

Fig. 2. Percentage of plasma inulin levels and total urine inulin excretion plotted against time in subject M. J.

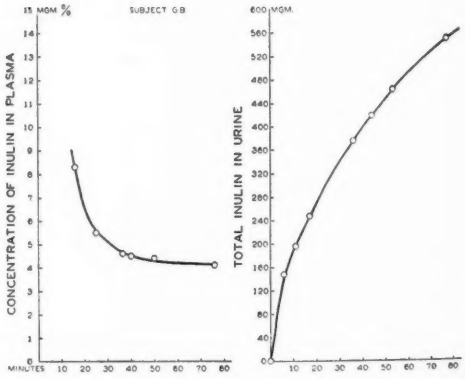

Fig. 3. Percentage of plasma inulin levels and total urine inulin excretion plotted against time in subject G. B.

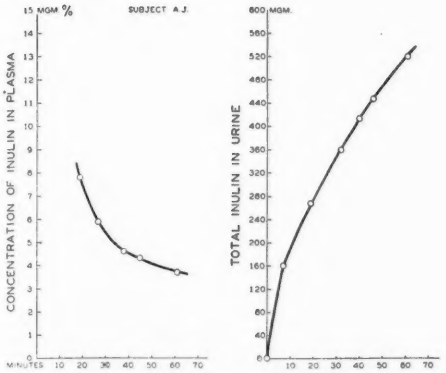

Fig. 4. Percentage of plasma inulin levels and total urine inulin excretion plotted against time in subject A. J.

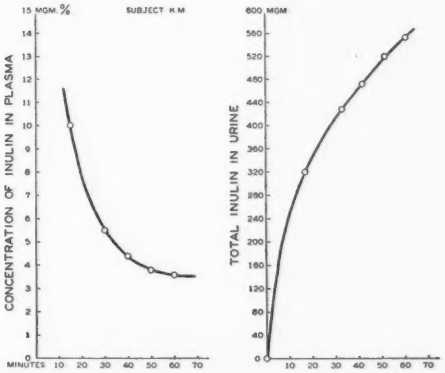

Fig. 5. Percentage of plasma inulin levels and total urine inulin excretion plotted against time in subject K. M.

RESULTS

The maximal volume of distribution of inulin occurs at 40 minutes in all subjects reported (Fig. 1). Our average value of the extracellular fluid, including plasma water, was 21.2 per cent of the lean muscle mass with a range of 19.3 to 25 per cent and an age range of 13 to 62 years (Table I).

If the last patient is omitted, the average extracellular fluid is 20.5 per cent of lean muscle mass with a range of 19.3 to 21.6 per cent. The last patient (W.C.) was under severe stress, highly nervous, and visibly upset with his gastrectomy imminent. He probably had an increase in extracellular fluid space. Subsequent diuresis and repeat measurements confirmed this suspicion.

THE CLINICAL METHOD OF EXTRACELLULAR FLUID DETERMINATION

From these results it is apparent that a simple clinical method of determining the extracellular fluid can be carried out by taking a blood and urine blank, then giving 1,000 milligrams of inulin intravenously, and at 40 minutes taking another blood sample and collecting the urine just afterward at 43 minutes. The test is repeatable in approximately 4 to 12 hours, depending upon the urgency of the case, and can easily be done daily.

For extreme simplicity (except in true oliguria and anuria) and without much error, one can omit the urine blank by assuming it to be zero and omit the blood blank by using

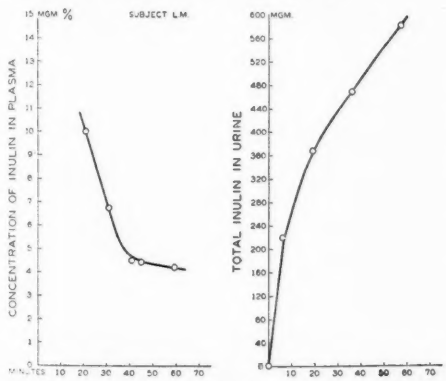

Fig. 6. Percentage of plasma inulin levels and total urine inulin excretion plotted against time in subject L. M.

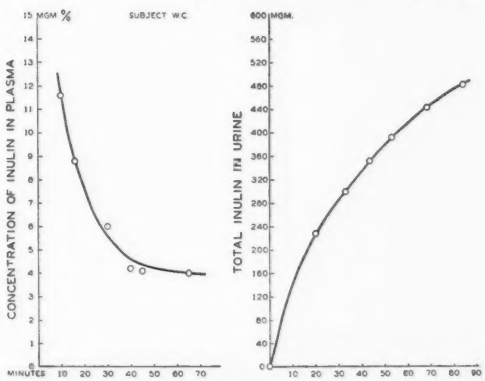

Fig. 7. Percentage of plasma inulin levels and total urine inulin excretion plotted against time in subject W. C.

our average value of 0.12 milligram per cent of inuloid material.

The plasma volume can be estimated simultaneously by the T 1824 dye method, and the difference between the two represents the extravascular, extracellular interstitial fluid. Errors in the dye method must be considered when this is done.

LIMITATIONS OF THE METHOD

Since inulin is hydrolyzed to fructose in the laboratory part of the procedure, an uncontrolled diabetic must be brought under control before the test can be carried out, and fats should not have been eaten prior to the test. If a blood sugar level is approximately normal, no difficulty is to be expected.

Definite essential hypertension with diastolic pressure over 110 to 120 millimeters of mercury may have decreased arteriolar flow and possibly decreased capillary permeability. In these cases the reading should be done at 60 and 70 minutes, where it is usually valid, although a 40 minute reading could be taken and corrected, as will be shown in a subsequent paper. A separate study has been made by us on permeability alterations in essential hypertension and on inulin extracellular fluid determinations in hypertension. This will be presented in the near future.

The validity of the method in high fever and exercise is being investigated. Where fluid accumulates in a closed endothelial lined space, no detectable amount of inulin is found 40 minutes following injection. This applies to pleural, ascitic, or spinal fluids. Such accumulations probably are not to be included in a statement of "available fluid."

SUMMARY

A simple clinical method for the estimation of extracellular fluid, repeatable in 4 to 12 hours, is presented.

Six cases with complete graphs are presented with an average extracellular fluid volume of 21.2 per cent of lean muscle mass and a range of 19.3 to 25 per cent. These cases include males and females from 13 to 62 years of age and persons whose body builds range from very fat to very thin.

The extracellular fluid expressed as percentage of total body weight ranges from 16.6 to 22.4 per cent with an average of 19.5 per cent.

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PREVENTION OF PANCREATIC FAT NECROSIS

An Experimental Study

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AN EXPERIMENTAL procedure has been described (4, 5) which leads to fatal intraperitoneal fat necrosis in a high percentage of animals; in dogs, the main pancreatic duct together with a collar of duodenal wall and mucosa was excised, and left open in the abdomen. The method seemed suited for the study of prophylactic and therapeutic measures applicable to clinical cases of pancreatic fat necrosis.

We have attempted previously to prevent pancreatic fat necrosis by intraperitoneal administration of soybean antitrypsin (2). This seemed to have some beneficial effect as far as mortality was concerned, but the results were not consistent enough to warrant continuation. Therefore, other trypsin inhibitors, mentioned by Calandra, Hardt, and Stanish were investigated; certain detergents had been found to be without any effect in previous experiments (3), and a few other trypsin inhibitors were too toxic to be tried. In the present work, sodium formaldehyde sulfoxylate (S.F.S.), acridine 36, and cysteine hydrochloride, all of them trypsin inhibitors according to Calandra and colleagues, were tried. Contrary to the experience of these authors, we have been informed that S.F.S. inhibits lipase but does not inhibit trypsin. Also, protamine sulfate, and a streptokinase-streptodornase combination were tried.

METHOD

Twenty-three male and female mongrel dogs, weighing between 6 and 10 kilograms were subjected to the operation described previously (4, 5). The animals were starved for 24 hours before operation, and during the postoperative period they were given water only. Penicillin and steptomycin were administered daily after the operation. Autopsies were carried out upon all of the animals.

In 2 dogs, 100 milligrams of acridine dissolved in 25 milliliters of distilled water were instilled into the peritoneal cavity at the end of the operation before the abdomen was closed, and the same quantity was injected intraperitoneally 24 hours later. In 3 dogs, 5 grams of cysteine hydrochloride suspended in 25 cubic centimeters of saline were instilled intraperitoneally at the end of the operation, and the same quantity was injected intraperitoneally 24 hours later. In 3 dogs, 100,000 units of streptokinase and 25,000 units of streptodornase, dissolved in 20 milliliters of saline, were instilled into the abdomen at the end of the operation, and the same quantity was injected intraperitoneally 24 hours later. In 2 dogs, 0.5 gram of protamine sulfate dissolved in 25 milliliters of 6 per cent gelatin-saline solution was instilled into the abdomen at the end of the operation. Thirteen dogs received S.F.S. intraperitoneally in amounts of 0.5 to 10 grams dissolved in 25 cubic centimeters of sterile distilled water or in 25 cubic centimeters of 6 per cent gelatin solution: 4 dogs received 10 grams S.F.S. once before the abdomen was closed; 9 dogs received daily intraperitoneal injections of S.F.S. for 2 to 4 days after operation, and 3 of them received an additional intraperitoneal injection of S.F.S. 6 hours after the operation.

RESULTS

The degree of fat necrosis was graded as follows: + + + extensive; + + marked; + moderate.

Acridine. One dog died 1 day, and the other one 2 days after operation, both with + + + fat necrosis.

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Supported by the Otto Baer Fund. The Department is in part supported by the Michael Reese Research Foundation.

Cysteine hydrochloride. Two dogs died 1 day after operation with + + + fat necrosis, and 1 animal died 2 days after operation with small bowel strangulation and + + fat necrosis.

Streptokinase and streptodornase. Two dogs died 2 days after operation, one with pneumonia and + fat necrosis, and one with + + + fat necrosis. The third dog was sacrificed 2 days after the operation, showing + + fat necrosis.

Protamine sulfate. Both animals died 2 days after operation with + + + fat necrosis.

Sodium formaldehyde sulfoxylate. Of 13 dogs which received S.F.S., 8 showed no fat necrosis and 5 showed fat necrosis. Four animals died with + + + fat necrosis, 1, 2, 3, and 8 days respectively after operation. The fifth dog did not appear to be sick, and was sacrificed on the third postoperative day, and showed + + fat necrosis. Of the 8 dogs without fat necrosis, 2 died with peritonitis 1 and 2 days respectively after operation, and the remaining 6 were sacrificed between the third and the fifteenth postoperative day.

The 2 dogs that died with fat necrosis 1 and 2 days after operation respectively, had received a single dose of 10 grams of S.F.S. The dog which died on the third day had received 2 grams of S.F.S. at operation, and 3 grams 6 hours later and daily for 2 days after operation. The dog which died with fat necrosis on the eighth day had received 0.5 gram of S.F.S. before closure of the abdomen, 0.5 gram the next day, and 3 grams on each of the following 2 days. The apparently healthy dog, which was sacrificed 3 days after operation and which showed extensive fat necrosis, had received 2 grams of S.F.S. during the operation and one dose of 2 grams daily on the following 3 days.

DISCUSSION

The administration of acridine, cysteine hydrochloride, protamine sulfate, and streptokinase-streptodornase was obviously without effect on the development of fat necrosis. However, the administration of S.F.S. seemed to be beneficial.

In our original experiments, 85 per cent of the animals developed fat necrosis. In the present series of experiments with acridine, cysteine, protamine, and streptokinase-streptodornase, 100 per cent of the dogs had fat necrosis. In the series treated with various doses of S.F.S., only 5 of 13 dogs (38.5 per cent) had fat necrosis. The data show that favorable results did not appear to be in direct relation to the amount of S.F.S. which had been administered. S.F.S. is the only antitrypsin so far tested by us that shows promising results which may be due to its inhibition of trypsin, or of lipase, or of both.

SUMMARY

Excision of the pancreatic duct, as described previously, caused intraperitoneal fat necrosis in 85 per cent of experiments. This procedure was used to test the ability of various substances to prevent fat necrosis of the pancreas.

In a previous paper, slightly beneficial effects with intraperitoneal administration of soybean antitrypsin were reported. The present experiments showed that intraperitoneal administration of acridine, cysteine chloride, streptokinase-streptodornase, and protamine sulfate had no beneficial effect.

The intraperitoneal administration of sodium formaldehyde sulfoxylate lowered the occurrence of fat necrosis from 85 to 38.5 per cent. This favorable result is possibly due to inhibition of trypsin or of lipase or of both.

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THE "LIGHT BULB" TYPE OF PROSTHESIS FOR THE FEMORAL HEAD

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THE prosthesis of the femoral head, in some form or several, is here to stay, at least until a better method is evolved to meet the problem of the painful, unstable, or stiff hip.

To condemn old people with malum coxae senilis, aseptic necrosis, or ununited fracture of the neck of the femur to the speculative adventure of a hip fusion is to assume a defeatist attitude toward the problem and necessitate a long bedridden period, a gloomy outlook and an uncertain convalescence. The result offers no more than a painless joint which for old people is disabling and cumbersome. Often both hips and the spine are involved in the same degenerative process and then a fusion cannot be considered. We have almost come to the conclusion that our type of prosthesis offers more for these conditions and also for the fresh fracture of the neck of the femur in the aged (65 years or over) than any other form of treatment, and that it has potentialities in other age groups as well.

We do not propose to argue the virtues and shortcomings of the various types of prostheses, but rather to introduce a series of results from the use of a prosthesis which was initially developed to meet the problem of the ununited and fresh fracture of the neck of the femur in the aged. Suffice it to mention the fact that those prostheses which involve extensive and shocking operative procedures with removal of considerable trochanteric and bony structure hardly seem justified for the elderly patient. Further, by performing such an operation, the surgeon burns his bridges behind him should complications develop necessitating removal of an elaborate prosthesis.

In meeting the problem of the old ununited fracture of the neck of the femur, we recognize that very often the distal portion of the neck is partially or completely absorbed and is therefore unsuitable for a Judet type of prosthesis which depends for its stability on the outer and shaped portion of a good long distal neck. In ununited fractures there only remains the strong cortical base of the neck with its spongy soft cancellous interior.

The idea was conceived that if the cancellous bone could be reamed out of the base of the neck, a seat against the entire inner cortical bone could be made for an elongated, tapering oval-shaped prosthetic stem. This would distribute pressure and stress over the entire architecture to the base of the neck through which this stress would be carried. In considering the structure of a prosthesis for the absorbed neck and fractured head of the femur, we concluded that since the triflanged nail proved an adequate method for internal fixation of a fractured femoral head to the neck, it should prove equally adaptable for stabilizing a foreign body prosthesis to the neck and shaft of the femur.

The original acrylic prosthesis looked like an electric light bulb; therefore the name, the "light bulb" (Thomson) prosthesis. Variations have been evolved but none have given evidence of improving on the original idea of developing a prosthesis with a round ball shaped head with an oval tapered neck cast on a 3½ inch S. M. O. stainless steel or vitallium triflanged nail which fits snugly into the inner cortical portion of the neck and is transfixed by the end of the nail at an appropriate angle into the strong cortical portion of the lateral shaft of the femur (Fig. 1).

The ball head is 1¾ inches in diameter. From the lower third of the ball is a slight ledge where the oval tapered neck extends 1½ inches at the end of which the triflanged nail protrudes. The ledge below the head gives additional weight-bearing surface against the distal end of the neck. The oval tapering neck begins from this ledge. The overall length is ordinarily 4 inches, although occasionally we

TABLE I.—ANALYSIS OF 59 CASES IN WHICH THOMSON PROSTHESIS WAS USED

Condition	No. cases	Average age, years
Nonunion, including 3 with previous osteotomy	17	71
Fresh fractures, including 3 hemiplegics, 1 with severe osteoporosis, 1 bilateral with prosthesis on other side for nonunion	27	76
Osteoarthritis	4	63
Aseptic necrosis	8	63
X-ray necrosis	1	75
Congenital dislocation of hip	1	12
Slipped capital femoral epiphysis	1	16
Age groups, years		
Over 90 (2 being 94 years old)	4	
80–90	10	
70–80	24	
60–70	14	
50–60	2	
40–50	3	
Under 40	2	
Complications		
Dislocations*—from (a) improper handling in postoperative period, (b) excessive valgus position of prosthesis, (c) shallow acetabulum, (d) adductor tightness	8	
Myositis ossificans—(a) trauma caused by dislocation, (b) mainly those with anterior approach	3	
Positive Trendenlenburg—majority of cases, dependent upon muscular stability; progressive improvement with use		
Peroneal palsy (transitory)—(a) 1 probably due to dislocation and anterior approach, (b) 1 due to plaster boot used to maintain postoperative position	2	
Lateral discomfort over prominence of prosthesis, stem too long (Smith-Petersen type)—mild, present when lying on involved side on hard surface	2	

*7 cases reduced and maintained with good function; 1 case not attempted, stable though motion limited but patient refused care.

use one 4½ inches in length. There is still the feeling of distrust in the durability of acrylic and particularly when metal protrudes from it. Though we use the original type of prosthesis in a majority of the cases we have one completely cast of acrylic with a stainless steel reinforcing rod and small rectangular end which is impinged into the lateral cortex of the femur. The latest development is a vitallium prosthesis which has the advantage of being made in one piece (Fig. 2).

The materials used or minor variations in design of the "light bulb" have in nowise influenced the results. The principles involved are all important and form the basis of our results. Among these principles are:

1. The "light bulb" through its oval tapering neck delivers the stress to the entire circumference of the inner portion of what cortical neck remains.

2. It is so firmly seated in its cortical and cancellous bed that it follows nature's anatomical and physiological mechanical lines of contour and stress when carrying weight.

3. The transfixion of the nail into the strong lateral cortex maintains the desired angle of the head to the neck and further distributes the stress to the femur.

4. The "light bulb," by restoring a more normal relation to the hip for hip joint function, increases the abductor fulcrum giving better stability and muscle action.

5. The enlarged and deepened acetabulum removes all degenerative cartilage and debris which gives a better security for the prosthesis.

6. Removal of the capsule apparently accomplishes a complete neurectomy and painless, good function usually follows.

The technique of operation is described in a preliminary report to be published in the *Journal of Bone and Joint Surgery*, and in brief consists of the following steps: (1) posterolateral approach; (2) capsulectomy; (3) enlarging and reaming out of the acetabulum; (4) saving all cancellous bone reamed from the neck to form a seat for the prosthesis and packing it deep in trochanteric substance along the course of the nail; (5) placing the "light bulb" at the proper angle in the neck and impinging the end of the nail firmly into the lateral cortex of the femur; (6) adductor tenotomy occasionally when adductor deformity is present.

The entire process should be completed in 25 to 45 minutes, and with minimal reaction to the patient.

We were very timid and skeptical in accepting this procedure as a rational approach to this problem. The first operations performed 2 years ago were on very old persons in desperate condition, in whom we felt sure that whatever was done at least would not materially reflect misfortune upon their outcome. Nine of the first 12 are still living and are very happy with their results. The demise of the

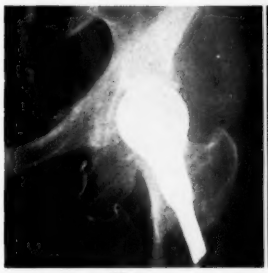

Fig. 1.

Fig. 2.

Fig. 1. Vitallium model of original "light bulb" type prosthesis as cast following form of acrylic prosthesis with Smith-Petersen nail. This is a 76 year old woman whose original disease was aseptic necrosis of the head of the femur. She is now walking with a cane without pain, 3 months following prosthetic replacement, though she tires easily.

Fig. 2. Final vitallium model showing ledge about base of head of prosthesis for more cortical end-bearing support. Note bone response about stem of prosthesis through lateral cortex on right. The replacement of the right hip was done 6 months previously because of nonunion of a fracture of the neck of the femur. This patient was ambulatory with cane support for the first time in 2 years. She fell and fractured the other hip, for which a similar procedure was then carried out. Patient is 82 years old.

ther 3 was not influenced by the operation in ny way and did not occur until some time ter.

In evaluating results, due consideration ust be given to the physical and mental atus of the patient prior to operation. To lustrate: A patient of 75 years who has en chair and bedridden for 6 months to a ear with a painful adducted or flexed nonnion of the hip cannot be expected to obtain he result of a patient of the same age who, in an active life, has a fresh fracture of the neck of the femur. Some of the patients with aseptic necrosis when relieved of their pain and discomfort are so happy with painless free motion that they become lazy in their training of muscle strength and endurance. The simple fact that they have an easier existence and demand less care seems sufficient to justify the procedure.

It is difficult to evaluate the results categorically in these cases as to function and walking ability because of the facts mentioned in the previous paragraph. However, by our present standards, the pain should be relieved practically 100 per cent. With our present technique an excellent range of motion has been obtained in all cases. Ambulation, however, depends upon muscle stability and this will vary with the patient. However, those most physically active generally are walking without support in 3 to 4 months. Those in the third and fourth decades of life are capable of carrying on almost normal activities. Even at the extremes of age, this may be quite remarkable as demonstrated by a 94 year old patient who, 5 months following the prosthetic replacement, was ambulatory without support and was caring for her small home by herself.

From January 1950 to January 1952, we have used 59 prostheses of our own design. The results are indicated in Table I.

Indications for the "light bulb" type of prosthesis are mainly confined in our experience to its use in older people, but its potentialities are relatively unexplored in the younger group. The indications for use of this prosthesis are as follows: (1) nonunion of the neck of the femur; (2) fresh fractures in old persons and particularly if there is little likelihood of union with unsatisfactory reduction and extensive trauma, or when it is desirable to obtain early functional use; (3) aseptic necrosis following healed fracture of the neck, dislocation or other trauma or pathology including extensive hypertrophic changes of the femoral head and acetabulum; (4) certain special pathological problems of the hip as osteoporosis and x-ray necrosis; (5) rheuma-

toid arthritis; (6) selected cases of congenital dislocated hips and slipped capital femoral epiphyses in children.

CONCLUSIONS

1. A simple type of hip prosthesis (the "light bulb") is described which follows the anatomical make-up and physiological stress of the normal head of the femur. The results of 59 cases in which it has been used seem to justify the opinion that it is not mutilating nor shocking to insert.

2. It restores a more normal relationship between the acetabulum and the shaft of the femur and also restores the abduction fulcrum mechanism.

3. It allows early painless function to the extent of the physical and mental capacity of the patient.

4. It converts an intra-articular fracture to an arthroplasty with soft tissue healing.

5. Experience has shown it to be well tolerated in old age and poor risk groups.

6. Its use must be limited to those with adequate orthopedic experience and judgment.

7. In our experience this prosthesis has been of benefit in every case in which it has been used and to our knowledge has proved superior to any alternative measure available.

8. The "light bulb" prosthesis offers potentialities and speculations beyond the scope of this presentation.

THE EXPERIMENTAL USE OF FASCIA IN THE REPAIR OF LARGE DEFECTS OF HOLLOW VISCERA

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SURGEONS are not infrequently confronted with the problem of closing defects in hollow viscera in the face of poor or insufficient substance for closure. The difficult closure of the duodenal stump at the time of gastrectomy, especially for duodenal ulcer, may be a troublesome example of this situation. Less frequently the satisfactory closure of colon, small intestine, stomach, or bladder defects becomes a problem. In many instances, although closure is possible, the operator may be uneasy because of questionable blood supply, scar tissue, or local infection. Under these circumstances it would be desirable to have available a material which might be used for reinforcing the line of closure.

The desirability of any material used as an autograft would at least partly depend upon its availability at the time of operation, the dispensability of the graft from the donor site, the ease of handling and application, and its survival for a length of time sufficient to assure healing. The use of fresh autograft material obviates the necessity for storing homograft materials. In this study fascia obtained from the anterior rectus sheath has been employed in the closure of defects of the stomach, colon, bladder, and the open duodenal stump at the time of gastric resection in the dog.

In evaluating the efficacy of grafts used for closure of visceral defects in the experimental animal, it would seem worth while to expose such grafts to the most adverse conditions under which such a graft might be used if evaluation is to be critical. This is mandatory if clinical application of results obtained in the experimental animal is to be attempted. The dog's resistance to peritoneal contamination is well known, and the ability of the muscular walls of hollow viscera to contract and rapidly seal small perforations is also established. Therefore, methods and materials which can be used in preventing leakage from visceral defects in a relatively small number of experimental animals may not necessarily lend themselves to clinical use. This study was designed to subject the test tissue, fascia, to stringent evaluation.

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METHOD

Nineteen adult mongrel male and female dogs weighing from 14 to 19 kilograms were used. The only preoperative preparation was the withholding of food for at least 10 hours prior to operation. Defects in the anterior wall of the stomach and bladder were made by scribing a circle on the serosal surface, 3 centimeters in diameter, with the scalpel. A full thickness excision of the wall was then carried out, that portion contained in the scribed circle being removed. The opening increased in diameter by at least one-third to result in a defect of 4 to 6 centimeters. A 4 centimeter disc of fascia was then removed from the anterior rectus sheath and was incorporated into the defect by using a Connell type suture of No. 00 chromic catgut (Fig. 1b, c). This procedure resulted in a closed defect 3 centimeters in diameter. As opposed to onlay graft techniques (Fig. 1a) the edges of the defect remained separated by a disc of fascia of approximately uniform size, since the fascia had been incorporated *into* the wall of the defective viscus. A few interrupted No. 40 cotton sutures were used at the edges of the graft on the serosal aspect. The muscle side of the graft was exposed to the interior of the viscus. This technique was employed in repairing defects in the stomach and bladder in two groups of 4 dogs each. An identical procedure was carried out in 2 dogs in which a 2 centimeter defect in the antimesenteric aspect of the midportion of the transverse colon was closed by

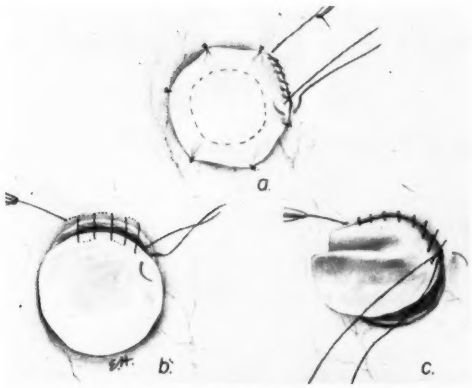

Fig. 1. Sketch showing method of closure used in stomach, bladder, and colon defects. a, Onlay technique used in 4 stomach defects. b and c, Inlay technique employed in all bladder and colon defects and 4 stomach defects.

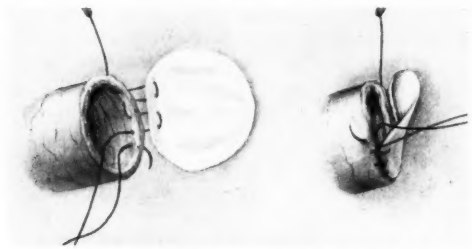

Fig. 2. Sketch showing method of duodenal stump closure.

using a 3 centimeter fascial disc. In 5 dogs a 3 centimeter disc of fascia was sutured into the open end of the duodenal stump at the time of subtotal resection (Polya) of the stomach. Here again it was incorporated into the wall of the viscus by use of a Connell suture (Fig. 2).

In addition, because of poor results previously reported in fascial repairs of gastric defects, gastric defects were repaired by the onlay method (Fig. 1a) in 4 additional animals. Patches of fascia were used to cover the defects by ignoring the mucosal edge and suturing the fascia directly upon the serosal surface at a distance of 0.5 centimeter from the edge of the defect. Otherwise, the technique was identical with that described.

The animals were sacrificed between 120 and 180 days postoperatively, and the viscera in which the grafts had been implanted were removed and examined grossly and microscopically.

RESULTS

None of the animals died, and none exhibited signs suggesting peritonitis. Those grafts placed in the wall of the stomach contracted to approximately half the original diameter (1.3 to 1.7 cm.). With 1 exception, the grafts were covered by mucosa grossly and microscopically at the time of sacrifice. In the case showing failure of epithelization, even though the graft had been in place 180 days, there was no sign of deep penetration despite the absence of mucosal covering.

In the 5 dogs having gastrectomies in which the duodenal stump was closed with a fascial graft, all healed without residual evidence of leak or inflammation. Grossly and microscopically the sealed end of the duodenum was covered with mucosa. In 2 animals there were adhesions between the closure site and adjacent viscera; in the other 3, no adhesions were present. One animal so treated, not included in this series, which died of distemper 8 days following operation, showed the graft to be intact with both surfaces covered by a fibrin coating. Because of the contour of the sealed area, it was difficult exactly to determine the extent of shrinkage of the graft in this site, but the external area encompassed by the silk sutures placed originally at the periphery of the graft appeared to be approximately one-third the size of the original graft.

Grafts placed in the bladder defects healed well, and good mucosal covering, both grossly and microscopically, resulted in 3 of the 4 animals used. In the other animal, bone formation at the site of transplantation resulted, and the calcified area which was 1.5 centimeters in diameter was devoid of mucosal covering at the time of sacrifice. As Neuhof previously suggested, this in no way appeared to interfere with the function of the organ. No calculi were found in any of the repaired bladders.

Both animals in which colon defects were closed with fascial grafts showed contracture of the graft mostly confined to an axis at right angles to the longitudinal axis of the bowel. This resulted in negligible decrease of bowel

Fig. 3. Photograph of mucosal aspect of stomach showing graft site with mucosal covering (above), and photomicrograph (×7.5) of section through graft site showing mucosal covering (below).

Fig. 4. Photograph of external aspect of healed duodenal stump following fascial closure (above), and photomicrograph of sagittal section (×3.5) of healed stump showing mucosal covering (below).

caliber at the point of graft. Mucosa grew completely across both grafts.

DISCUSSION

The results of these experiments confirm the results of earlier investigators in some respects but differ rather markedly in others. Neuhof also reported a high degree of success in the fascial closure of bladder defects, but, whereas he reported the invariable formation of bone at the site of transplanted fascia, this phenomenon occurred in but 1 of 4 of the animals used in these experiments. Koontz reported healing and mucosal covering following the use of preserved ox fascia in similar experiments. Lord and associates reported the successful use of rectus sheath fascia grafts in repairing ureteral defects when these grafts were fashioned into a cuff and placed about a vitallium tube. They found that epithelization occurred regularly, but report calcification in 1 graft. Neuhof quotes Kirschner as having used a fascial graft to close a 10 by 12 centimeter defect in a human bladder at the time of repair of an exstrophy. At the time of the patient's death from pyelonephritis 44 days later, the graft was said to be "normal in structure and staining." No mention was made regarding epithelization. Animal experiments in this laboratory are presently being carried out to determine the efficacy of fascial graft closures of large experimentally produced exstrophies. Although calculi were not found to form in the presence of these transplanted fascial grafts, the duration of the observation period was not sufficiently

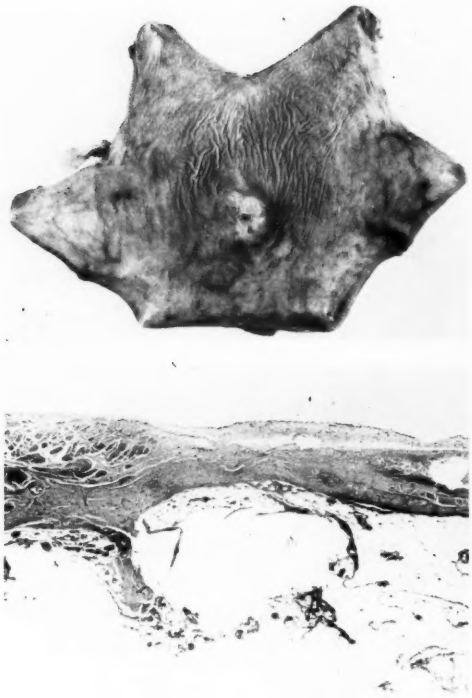

Fig. 5. Photograph of mucosal aspect of urinary bladder showing healed graft near center (above), and photomicrograph (×8.5) of section through graft (below).

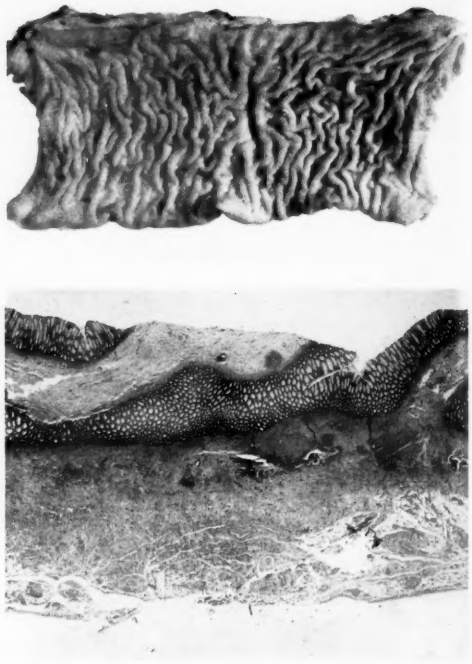

Fig. 6. Photograph of mucosa of transverse colon showing healed graft (above), and photomicrograph (×9) of section through graft showing mucosal covering (below).

long to assure that their formation would not occur later. However, it would seem that mucosal covering as occurred in 3 of the 4 test animals would tend to prevent stone formation to some extent.

The closure of gastric defects has likewise been successful in the 8 animals in which defects were repaired by onlay or inlay type grafts. Koontz reported perforation when preserved ox fascia was used unless antacids were administered postoperatively, and Neuhof stated that gastroenterostomy was necessary to prevent perforation. Neither method was employed in these experiments, and an explanation is lacking for the poor results obtained by these investigators unless the use of a preserved heterograft explains the failures in the experiments carried out by Koontz. It is interesting to note that Moore and Singleton recently reported the successful closure of gastric defects with free peritoneal onlay grafts with only 1 perforation in 4 animals tested. Their work and the experiments herein described would raise question as to the preference of one method of suture over another, as Neuhof suggested, providing fixation is adequate with tight apposition of graft and recipient surfaces. These results indicate that in the dog the resistance of anterior rectus fascia to acid-peptic activity is high.

The fascial closure of the open duodenal stump at the time of gastrectomy (Polya) resulted in a completely healed mucosal lined stump. Three of the 5 animals so treated showed clean healing without adherence to pancreas or other adjacent viscera, which in-

dicates that primary healing by virtue of the graft alone is possible. In the other 2 animals the healed stump was found to be adherent to the pancreas, but no evidence of old or recent inflammation in the pancreas was present in either animal at the time of sacrifice.

In the 2 animals in which defects of the transverse colon were repaired, healing and mucosal covering resulted with but slight narrowing of the caliber of the colon. This occurred despite the closure of a sizable (2 cm.) defect if the diameter of the dog's colon is considered.

In no animal used in these experiments did the area into which a graft was transplanted show any evidence of weakening or of diverticulum formation. Since the formation of diverticula usually depends upon pulsion forces acting for prolonged periods, the test period may not have been long enough to rule out the possibility of their eventual development. Although most of the mucosal aspect of the grafts appeared umbilicated, microscopic sections revealed epithelization in all animals except for 1 bladder and 1 gastric graft.

SUMMARY

Defects in the stomachs, bladders, and colons of 8, 4, and 2 dogs respectively were repaired by the application of fascial grafts removed from the anterior rectus sheath. In addition, at the time of partial gastrectomy, the duodenal stumps of 5 animals were closed with fascial inserts. In no instance did perforation of the viscus occur, and all animals survived for periods ranging from 120 to 180 days, when they were sacrificed. Epithelization failed to occur but twice, once in the bladder and once in the stomach. From the observations made in this study, it would appear that segments of the anterior rectus sheath of the dog used as a free autograft afford an easily handled readily accessible material of high resistance, with a good capacity for healing when used in the closure of defects of these viscera.

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STUDIES ON VENOUS BLOOD PRESSURE IN PATIENTS UNDERGOING MAJOR SURGICAL PROCEDURES

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IT is generally agreed that the fundamental cause of surgical shock is decrease in effective circulating blood volume. A corollary to this is decreased cardiac output. Reduction in venous pressure has been observed as a part of the general picture in surgical shock. In the operating room it has become a standard procedure to record arterial blood pressure at frequent intervals in the patient undergoing surgical operation. The maintenance of a certain level of systolic arterial blood pressure is assumed to indicate the absence of shock. When the circulating volume of blood is reduced after blood loss, the arterial blood pressure falls and this is regarded as an index to the degree of shock. Experience has shown that in very radical surgery for advanced cancer there may be considerable blood loss which, for a brief period, may not be reflected in the systolic blood pressure readings; then, if the blood replacement has not been prompt, the arterial blood pressure may fall precipitously, even dropping to zero. In an endeavor to find means for detecting impending shock, i.e., significant reduction in circulating blood volume, before the fall in arterial blood pressure, studies on venous pressure in patients undergoing surgical operations of various types were carried out.

Moon showed in the experimental animal that low venous pressure usually preceded the fall in arterial pressure in surgical shock.

The normal limits of venous pressure are extremely variable not only in different patients but in the same patient. The pressure varies in different veins of the body and is also influenced by the position of the patient on the operating table as well as by the medication, anesthesia, and operative maneuvers. Therefore, the clinical application of venous pressure determination is limited to a comparison of values in any one vein in a patient. The baseline readings for that particular individual are determined after the induction of anesthesia and with the patient in proper position on the table for the given surgical procedure. In these studies, the authors sought to answer specifically the following questions: (1) Are repeated venous pressure readings during an operative procedure a significant index of the circulatory status of the patient? (2) Are venous pressure determinations an aid in estimating the patient's circulating blood volume during operation? (3) Are venous pressure readings of value in determining the blood replacement necessary during surgical procedures?

The study presented is based upon the venous pressure readings in 60 patients subjected to major surgical procedures. Actually many more observations have been made. For the most part the operations were radical and associated with extensive dissection and appreciable blood losses. The following summarizes the number and type of operations performed: radical hysterectomy and node dissection in 16 cases, complete pelvic exenteration in 10 cases, small bowel resection in 4 cases, partial pelvic exenteration in 4 cases, resection of recurrent pelvic carcinoma in 3 cases, pancreatoduodenectomy in 3 cases, radical excision of cervical stump and pelvic nodes in 3 cases, total hysterectomy and bilateral salpingo-oophorectomy in 3 cases, exploratory laparotomy in 3 cases, gastrectmoy in 3 cases, and miscellaneous types of operations (splenectomy; radical vulvectomy; omentectomy; radical mastectomy; radical cystectomy and node dissection; ventral

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This work was aided by grants from Mr. and Mrs. Andre Meyer of New York and Mr. Edgar Soreng of Chicago.

herniorrhaphy; hepatectomy; resection of pelvic sarcoma) in 8 cases.

In this series all patients received the same type of anesthesia, namely, sodium pentothal and d-tubocurarine induction, followed by endotracheal ether and oxygen, which was administered by the same anesthesiologist. A subsequent report is now in preparation on a second series of cases in which hypotensive anesthesia was employed. The present series included both male and female patients varying in age from 12 to 73 years.

METHODS

The routine treatment included preoperative and postoperative blood volume determinations employing the Evans blue technique. On the operating table, prior to anesthesia, a 15 gauge needle was inserted in a large vein of the right arm for the administration of sodium pentothal solution, fluids, and blood. Following the induction of anesthesia, a 15 gauge needle was introduced into the median basilic vein of the patient's left arm. A spinal manometer was attached to the armboard, placing the zero mark at 10 centimeters above the table mattress according to the method of Lyons and associates. With the use of a three way stopcock and plastic tubing, a bottle of isotonic saline solution delivered a continuous slow drip infusion through the needle into the patient's vein. The three way stopcock and manometer inserted between the saline bottle and the vein made it possible to determine direct venous pressure readings at any time during the operative procedure. These readings were made in terms of millimeters of normal saline solution in the spinal manometer. This system is illustrated in Figure 1, and is based upon the method of Moritz and von Tabora. The entire setup is composed of standard hospital equipment.

Arterial and venous pressure readings and pulse determinations were noted with the patient in supine, lithotomy, Trendelenburg, and supine jackknife positions. These records served as a baseline for comparative readings during the operative procedure. Repeat readings of pressures and pulse were taken throughout the operation. They were taken usually at

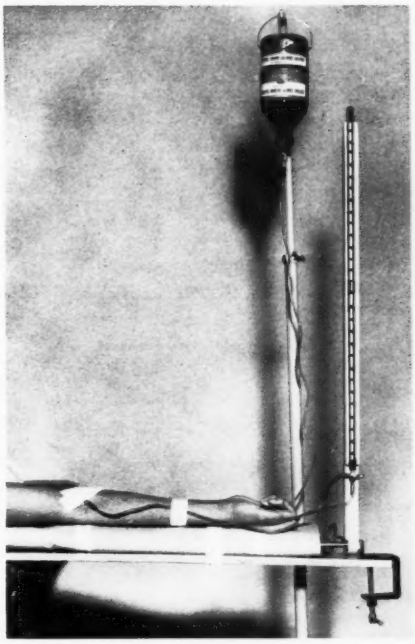

Fig. 1. A method of measuring directly venous blood pressure in millimeters of normal saline solution.

5 minute intervals, although more frequent observations may be necessary under conditions of excessive blood loss. The used sponges and lap pads were weighed continuously during the entire procedure in an attempt to estimate the blood loss. If a suction bottle was being used, its contents were weighed at frequent intervals. A record was charted of the measured blood loss and fluid and blood replacement simultaneously with the venous and arterial pressures and pulse rate.

FINDINGS

It became apparent from the venous pressure determinations made on patients in the various positions described that the normal levels for specific veins will vary from one person to another. The influence of gravity on the pressure within the venous system was well demonstrated by the variations shown in change of position. The lowest venous pressure was that with the patient in the supine position. The pressure was increased by

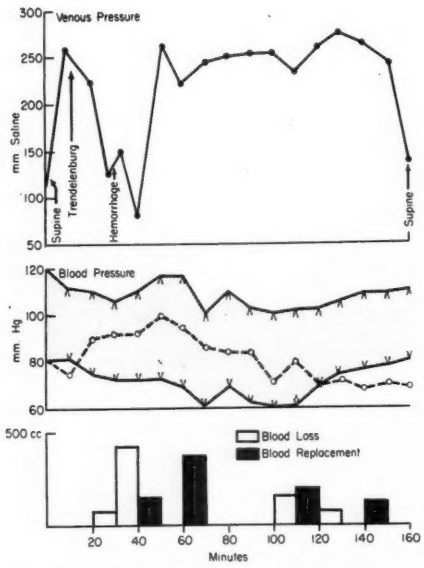

Fig. 2. Patient, B. P., white female, aged 24 years. Diagnosis: carcinoma of ovary. Operation: resection recurrent carcinoma of ovary, appendectomy. Drop in venous pressure secondary to hemorrhage without marked change in arterial blood pressure.

lithotomy and supine jackknife positions, and the maximum pressure in the arm veins was noted with change to the Trendelenburg position.

In addition to venous pressure variations noted with change in position other factors were apparent. The venous pressure decreased with marked deepening of anesthesia and with the insertion of tight abdominal packing which may restrict the venous return from the lower half of the body. Conversely the venous pressure was elevated during exploration of the abdomen, traction on abdominal viscera, or torsions of the liver. It is for these reasons that the observer must watch the operative field to correlate the venous pressure readings with blood loss and blood and fluid replacement.

In a few instances neosynephrine was administered. Although this agent caused a substantial elevation in arterial blood pressure, the venous pressure showed either an elevation of short duration or no significant change.

In all cases associated with blood loss, there was a significant fall in venous pressure if the blood was not replaced. *It preceded the fall in arterial pressure and the increase in pulse rate.* In these instances the arterial pressure was thought to be maintained by the compensatory mechanism of the body acting via the sympathoadrenal system as described by Moon.

In reviewing the records of the patients in the presented series the quantity of blood loss required to produce significant changes in venous pressure varied considerably. In 1 instance a blood loss of 66 cubic centimeters produced fall in the venous pressure as illustrated in Figure 2. In another patient, the loss of 300 cubic centimeters of blood was required to cause a fall in venous pressure. In neither case, however, was there a warning change in arterial pressure or pulse. Further study of these patients revealed a significant difference in the preoperative total blood volume. In the first instance the patient's preoperative blood volume was markedly decreased and was not corrected to normal prior to operation. The second patient was noted to have a normal preoperative blood volume. In general, patients with normal blood volume prior to operation will tolerate larger blood losses before significant lowering of venous pressure occurs than those patients with reduced preoperative blood volumes. This fact demonstrates the labile status of patients in so-called "chronic shock," i.e., those with diminished blood volume. These patients usually have normal arterial blood pressure and pulse rate and show no clinical evidence of shock prior to operation. Their hemoglobin and hematocrit determinations also may be within normal limits. Venous pressure readings during emergency surgical procedures on such patients may prove to be of considerable value. Significant falls in venous pressure would require urgent replacement of blood loss before the arterial pressure and pulse changes of shock are manifested.

In this series of patients there were many with appreciable blood loss. In a few cases, no attempt was made to replace the measured blood loss until the arterial pressure started to decline. With the administration of whole

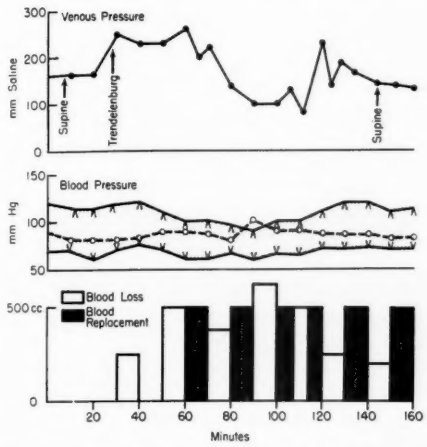

Fig. 3. Patient, T. M., white female, aged 57 years. Diagnosis: carcinoma of cervix. Operation: cystectomy, resection of recurrent carcinoma of cervix, ureterosigmoidostomies. Arterial blood pressure maintained to almost preoperative levels with decreased venous pressure due to inadequate blood loss replacement.

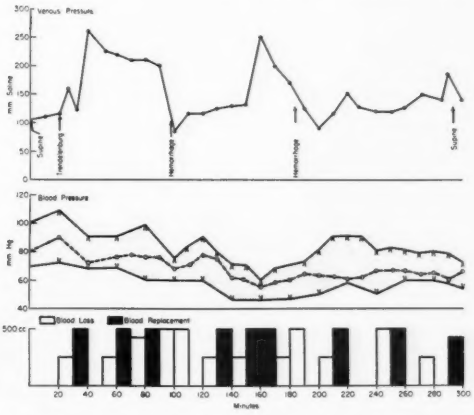

Fig. 4. Patient M. M., white female, aged 45 years. Diagnosis: carcinoma of cervix, stage iv. Operation: total pelvic exenteration. Increased venous pressure due to excessive blood replacement while the arterial blood pressure remained depressed.

blood, it was noted that the arterial pressure returned to normal limits before a quantity sufficient to replace the measured loss had been given; in these instances the venous pressure failed to return to normal until a quantity of blood commensurate with the loss had been administered as illustrated in Figure 3. Here again the greater accuracy of venous pressure readings in evaluating the circulatory status was demonstrated.

In a few cases a quantity of blood in excess of the measured loss was administered. The venous pressure was noted to rise above the normal limits for that particular patient as shown in Figure 4. In this patient the measured blood loss was 825 cubic centimeters during the first 120 minutes of the operation but the replacement amounted to 1,500 cubic centimeters during this period. The venous pressure had decreased with the loss, but rose to a level of 260 millimeters of saline after overreplacement, compared to the patient's normal of 126 millimeters of saline. The arterial pressure had fallen and remained depressed in spite of replacement therapy. Had the replacement been based upon arterial pressure alone, one could have overtransfused this patient to the point of cardiovascular failure. From individual studies in this series of patients it might be concluded that it is dangerous to administer blood to a patient on the sole indication of depressed arterial pressure with a venous pressure within normal limits. Sympathomimetic drugs would seem to be the therapy of choice. In actual practice patients have been fatally overtransfused when sole reliance was placed upon arterial blood pressure determinations.

To evaluate the adequacy of the blood replacement based upon venous pressure determinations, it is necessary to have objective criteria rather than a clinical interpretation of the patient's status. It was evident in this series of patients that a comparison of preoperative and postoperative blood volumes represented a relatively accurate criteria.

SUMMARY

1. An analysis has been presented of the venous blood pressure observed in 60 patients who were subjected to major operative procedures.

2. Venous blood pressure was observed to be more sensitive than the arterial pressure or pulse rate in detecting and evaluating operative blood loss and the degree of shock when surgical shock is in evolution. This is an indicator of impending shock.

3. Blood replacement based upon venous pressure determinations was satisfactory in this series of patients.

4. Experience is necessary in evaluating the changes in venous pressure and interpreting their significance during surgical procedures.

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EXPERIMENTAL INTRAPLEURAL SUBSTITUTION OF THE RIGHT COLON FOR THE RESECTED ESOPHAGUS

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THE present study was undertaken to determine whether the right colon could be used as an artificial gullet and if so whether it would be feasible for use in man.

Accordingly, operations were planned and carried out on 15 dogs. It was thought best to perform the operations in two or three stages to minimize shock from a prolonged procedure.[1]

Most of the operations were performed in two stages, the first a laparotomy, and the second a thoracotomy with incision of the diaphragm. In 4 cases a preliminary laparotomy was performed for the purpose of partially dividing the blood supply to the right colon in order to promote collateral circulation, as suggested by Shumacker and Battersby for improving circulation when they used the jejunum intrathoracically for esophagoplasty.

The dogs in most cases were given sulfathalidine before operation and streptomycin and penicillin before and after operation. The value of these agents in this series is questionable in view of the number of infections which occurred (Table I). Unfortunately bacteriological studies were not made, but might have proved interesting.

The first stage procedure consisted of section of the transverse colon and anastomosis of the proximal stump to the stomach anteriorly, the terminal ileum being then divided and the distal segment closed. The proximal ileum was joined by end-to-end anastomosis to the left colon. The second stage procedure consisted in bringing the right colon up into the left chest where the proximal stump was anastomosed to the esophagus after resection of a portion of the esophagus and closure of its distal stump. This procedure was later modified several times because of certain errors which became apparent. The sequence of technical procedures in the first stage was changed in order that the operation might be discontinued at any time that the dog's condition would indicate the necessity for this action, without losing the benefit of work already accomplished. The ileocolic anastomosis was made first, the terminal ileum closed, and the gastrocolic anastomosis was done last.

After 3 attempts to use the right colon with the cecum still attached, it became apparent that the cecum was worthless because of the small communication between its lumen and that of the colon proper. For this reason the terminal ileum and cecum were resected and the colon closed, instead of the terminal ileum.

The anastomosis of the colon to the anterior aspect of the stomach proved to be unsatisfactory because the frequently distended stomach exerted tension on the middle colic vessels and caused a kinking of the colon at the point of their attachment. The effect of this mechanical difficulty is well illustrated in the photograph (Fig. 1) and diagram (Fig. 2). This pulling of a dilated stomach on the middle colic vessels not only caused obstruction of the transplanted colon, but theoretically could result in ischemia and gangrene of the colic segment. Feeding was a difficult problem in this animal. Only liquids and thin semiliquids would pass through the artificial esophagus. Because of the unfavorable effect noted, the technique of gastrocolic anastomosis was changed and the gastric stoma was placed posteriorly with satisfactory correction of the defective procedure.

Another observation which seems important is that for best results the transverse colon

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The opinions expressed are those of the author and are not to be construed as official or reflecting the views of the Navy or the Naval Service at large.

[1] Anesthesia was obtained with 30 milligrams of sodium pentobarbital per kilogram of body weight, administered intravenously as a solution containing 50 milligrams of the drug per cubic centimeter, after morphine sedation.

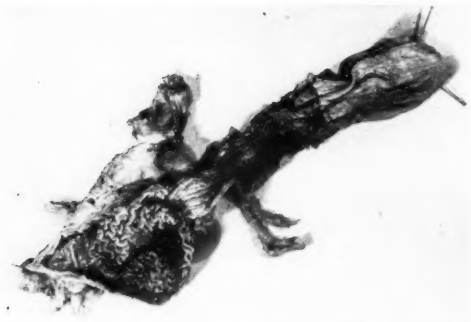

Fig. 1. Specimen of esophagocologastric segment of the alimentary canal of dog No. 6030. The specimen is split longitudinally to show the mucosal surface. Esophagus in upper right third of specimen; transplanted colon in middle third; and stomach in lower left. Below the colon can be seen attached mesocolon and middle colic vessels. Note hyperemia and congestion of colon where it was kinked due to traction by middle colic vessels as a result of distended stomach.

must be transected at about the level where it is joined by the middle colic artery and vein. In 1 case an attempt was made to divide the colon to the left of the middle colic vessels in order to acquire greater length for use in the chest. This proved useless because the vessels did not permit the right colon to be brought any higher in the chest and there was a redundant loop of colon proximal to the gastrocolostomy.

The gastrocolic anastomosis should be placed as high on the posterior wall of the stomach as possible in order to prevent obstruction of the lower end of the colic esophagus when the stomach distends. Figure 3 shows the valve mechanism involved in obstruction of the lower end of the colon when its stoma is located too low on the stomach.

The obstruction of the colon by a distended stomach, when the gastrocolic anastomosis is placed anteriorly or too low on the posterior wall of the stomach, is of special significance in cases in which the vagus nerves have been traumatized or sectioned during esophagectomy or esophageal section, resulting in loss of parasympathetic tonus.

Three dogs in this series (Nos. 6060, 6061, and 6068) had greatly dilated stomachs at necropsy. One dog with a diaphragmatic hernia had a dilated stomach occupying the entire left side of the thorax, crowding the

TABLE I.—DATA ON EXPERIMENTS

Dog No.	Stage 1	Stage 2	Stage 3	Death	Observations and necropsy findings
6024	4-23-51			4-29-51	Purulent peritonitis from leak of gastrocolic anastomosis secondary to ischemia of colic segment
6025	4-30-51	5-21-51	6-18-51	6-19-51	No abnormal findings. Death due to surgical trauma?
6028	5-7-51			5-9-51	Consolidation of both lungs. Distemper? The only operative procedure in this case was ligation of 2 primary arcades of rt. colic artery
6030	5-14-51	6-4-51	7-27-51	8-9-51	No abnormal findings. Cause of death inanition? Stomach distended with gas. Liquid food and secretion in stomach
6033	5-22-51	6-11-51		6-21-51	Purulent peritonitis. Leak of closed stump of ileum. Failure of circulation to cecum
6036	5-28-51	6-26-51		7-3-51	Purulent peritonitis. Leak of ileocolic anastomosis?
6049	7-11-51	8-3-51		8-9-51	Pyrothorax from soiling at operation
6051	7-20-51	8-10-51		9-30-51	No necropsy. This dog used in a lethal experiment by another surgeon through an error
6058	10-28-51			12-5-51	Pyrothorax (from soiling at operation?)
6060	11-7-51	11-21-51		12-31-51	Intestinal obstruction due to adhesive band. Greatly dilated stomach containing air and 500 gm. of food
6061	11-8-51	11-23-51		11-25-51	Intestinal obstruction from diaphragmatic hernia. Enormously distended stomach filled entire left pleural cavity
6068	1-9-52			1-27-52	Purulent peritonitis from leak of colic stump
6071	2-13-52			2-15-52	No abnormal findings. Death due to surgical shock? One stage procedure
6080	3-6-52			3-9-52	Diaphragmatic hernia with greatly distended stomach. One stage procedure
6092	4-3-52	4-17-52		Observed	This dog living and healthy; maintaining weight. Esophagocologastrostomy functioning well

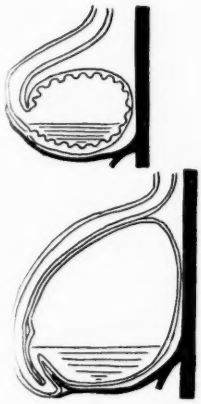

Fig. 2.

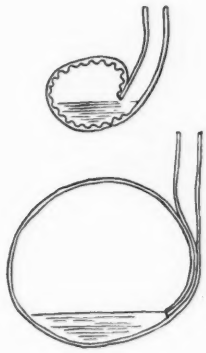

Fig. 3.

Fig. 2. The upper diagram represents the colon anastomosed to the stomach anteriorly. The aorta and middle colic artery are shown in solid black. The lower figure represents the stomach distended with gas, resulting in a kink of the colic esophagoplasty. The middle colic artery does not stretch to compensate for the distention of the stomach.

Fig. 3. The upper diagram shows anastomosis of the colon low on the posterior gastric wall. The lower figure illustrates the mechanism of obstruction of the esophagoplasty where the stomach is greatly distended, when the anastomosis is placed too low.

thoracic viscera over against the right chest wall. Sauerbruch, quoted by Fischer, had a similar experience with one of his dogs about a half century ago. With pyloric spasm and obstructed esophagoplasty there is no relief for such distention except gastrostomy, since a tube cannot be passed through the obstructed esophagus while the stomach is dilated.

The use of an additional stage to produce improved circulation to the right colon was abandoned, as the added traumatic insult to the animal is not justified by the results. One animal died of distemper 2 days after the partial ligation of colic arcades was carried out. This was a surgical death not directly connected with the type of procedure employed. It is sufficient to test the circulation by the application of bulldog clamps to the vessels whose division is contemplated. After 10 minutes, if there is no cyanosis of serious degree, no hyperperistalsis, or if pulsation can be detected in the artery, it is safe to perform the section of the clamped vessel. This procedure is the same as recommended by Christophe.

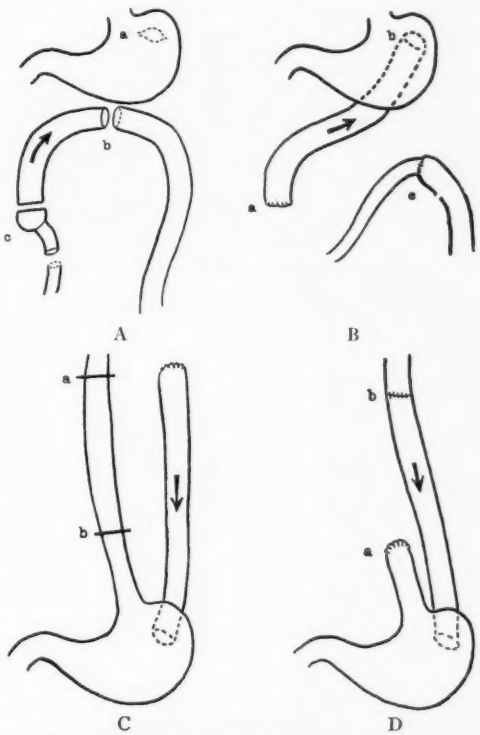

Fig. 4. Technique of experimental esophagocologastrostomy. Arrows indicate direction of peristalsis in the colon: A, *a*, Incision in posterior wall of stomach; *b*, section of transverse colon; *c*, resected terminal ileum and cecum. B, *a*, Blind closure of proximal end of right colon; *b*, cologastrostomy; *c*, ileocolostomy. C, Esophagus resected between *a* and *b*. D, *a*, Closure of distal esophagus; *b*, esophagocolostomy.

Anatomically, it is impossible to escape the conclusion that the right colon is unsatisfactory as a plastic substitute for the esophagus in the dog. The right colon is too short to reach higher than the aortic arch. In all cases in this series, the anastomosis of esophagus to colon was below the arch of the aorta.

On anatomic grounds also rests another objection to the right colon for esophagoplasty in the dog. The lumen of the dog's colon is very small. There is marked disproportion between the enormous esophagus and the smaller colon. Large boluses of food such as dogs gulp are sure to meet an obstruction in the colic segment of the new esophagus.

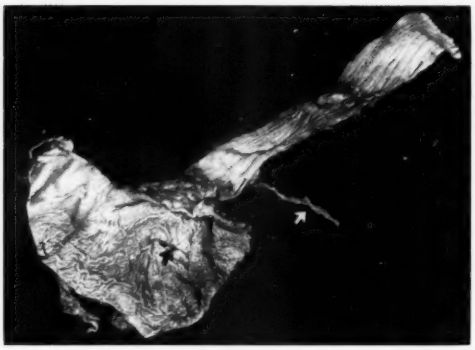

Fig. 5. Photograph of esophagocologastric segment of the alimentary tract (dog No. 6060) 40 days after grafting the colic segment. The esophagus and colon have been split longitudinally showing the mucosal surface. The anterior wall of the stomach has been removed showing the mucosa of the posterior wall. The black arrow indicates the esophagocolic stoma. The white arrow points to the middle colic vessels which are the vascular supply to the transplanted right colon. The esophagocolic union is seen at the upper right. The papilla near this junction is the closed ileal stump.

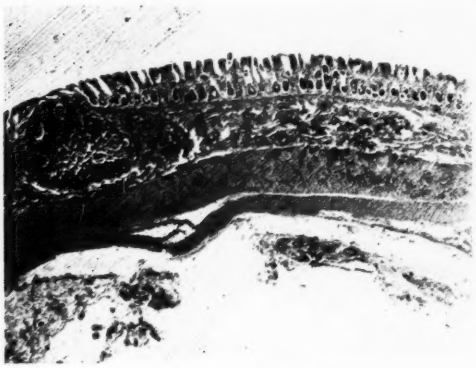

Fig. 6. Photomicrograph of colonic transplant for intrathoracic esophagoplasty in dog No. 6060, 40 days after esophagocologastrostomy. Note all the layers of the intestinal wall appear normal except for some atrophy of the mucosa and thickening of the connective tissue beneath the muscularis mucosae. There is a large lymphoid nodule in this layer near the left of the photograph.

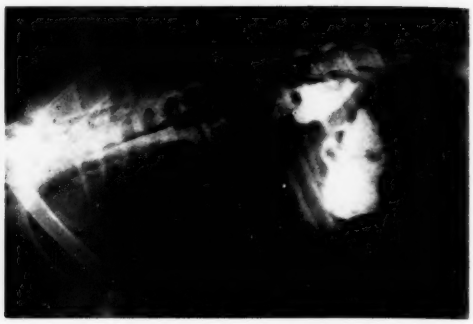

Fig. 7. Photograph of roentgenogram of dog No. 6092 during ingestion of a barium meal. This x-ray visualization of the esophagus and stomach was performed 35 days after esophagocologastrostomy.

Fig. 8. Roentgenogram of human colon with right colic and ileocolic arteries ligated and middle colic artery injected with 20 cubic centimeters of 70 per cent urokon solution. Arrows indicate points of ligation of right colic and middle colic vessels. Clamp and ligature are on the middle colic vessels. The contrast material was injected with only gentle pressure.

Still another objection to the use of the dog's right colon as an esophagoplastic material is the inconstancy of the vascular arcades of the middle and right colic arteries. Such lack of uniformity in the mesenteric vessels of dogs and cats has been noted by other investigators. Two cases of ischemia of the bowel in this series resulted in breakdown of intestinal suture lines and peritonitis (dog Nos. 6024 and 6033).

The procedure which was ultimately found most satisfactory in this experiment is illustrated by the diagrams in Figure 4. Figures 5 and 6 illustrate the gross and microscopic ap-

pearance of a satisfactorily functioning right colic intrapleural esophagoplasty.

The results obtained demonstrate that the anastomosis between the esophagus and colon heals quickly and is very strong.

DEFECTS NOTED IN ESOPHAGOPLASTY PROCEDURES

All the methods of esophagoplasty, now in use and proposed, fall short of an ideal reconstruction of the esophagus. Great progress has been made in this field and still greater improvement is in prospect. The mistakes and shortcomings in older methods can help us to obviate errors in our technique, if we are fully cognizant of them. Many pitfalls have been observed in esophagoplasty and some of these will be considered.

The dermal plastics appeal to the inexperienced, but are really complex and difficult to carry to a satisfactory conclusion. This is especially true of the total dermal plastic. Often many operative stages are necessary, with long intervals between stages, resulting in a greatly prolonged period of treatment. These stages are often made necessary by failure of primary wound healing, infection, and defective vascular supply to flaps, resulting in gangrene.

Gastric juice from a leaking gastrostomy often causes severe dermatitis. If a surgical procedure is begun in the presence of such an excoriation of the skin, a cellulitis of the subcutaneous tissues may develop which will not only cause delay but may jeopardize the entire procedure. In the partial dermal esophagoplasties there is less likelihood of the gastric juice spilling onto the skin surface. As a result, these plastics are more often successful than the total dermal plastic.

Some dermal plastic procedures fail because of faulty methods of raising and transplanting. This is apt to occur if the surgeon is inexperienced in handling such grafts.

Multiple stages of a dermal procedure often leave the patient extremely disfigured. Rapin had in mind such poor cosmetic results when he referred to his method of esophagoplasty as an "esthetic procedure."

Fistula formation is a common defect in dermal esophagoplasty. This condition is prone to develop at the gastrocutaneous junction.

Stricture at the dermatogastric juncture is a serious complication. Such strictures can only be dealt with satisfactorily by additional surgical intervention. This has been required repeatedly in some instances.

Jejunal plastics sometimes fail because the blood supply proves inadequate. Mes says that more jejunal transplants perish than survive. Vascular aberrations are frequently encountered and sometimes it is impossible to get a sufficient length of jejunum with adequate blood supply for a total reconstruction of the gullet. On the other hand, several writers have mobilized segments of the jejunum from 60 to 100 centimeters in length with adequate arterial supply.

Subcutaneous bowel transplants eventually lose their peristalsis according to Rovsing. Those who have had experience with skin tube esophagoplasty deny the necessity for peristalsis; however, it seems that peristalsis is desirable, even though not essential. Peristalsis might better be expected to persist in intrapleural esophagoplasty than in prethoracic, when a part of the alimentary tract is substituted for the esophagus, since the intrathoracic tube is less likely to be bound and immobilized by adhesions. Peristalsis was observed in the transplanted segment of colon in dog No. 6092 by fluoroscopy and barium swallow 35 days after esophagoplasty. Figure 7 is a photograph of a roentgenogram taken at the time of the fluoroscopy.

A common failing in extrathoracal esophagoplasty involving segments of bowel is the tendency toward stricture formation at the point where the transplanted loop passes through the abdominal fasciae. There is no simple means of correcting this complication except reoperation.

The principal objection to colon esophagoplasties in the past has been the danger of infection from the virulent flora in the lumen of this portion of the bowel. With the advent of chemotherapy and the use of antibiotics this danger has been appreciably reduced. Another objection to the use of colon for the esophageal replacement is the possibility of fistula formation at the esophagocolic anas-

TABLE II.—RELATIONS OF LENGTH OF HUMAN RIGHT COLON TO XIPHOID-MASTOID DISTANCE OBTAINED FROM 20 CONSECUTIVE NECROPSIES

Necropsy No.	Age, years	Sex	Length of rt. colon, cm.	Xiphoid-mastoid distance, cm.
1	74	M	59	42
2	71	M	45	38
3	7	M	36	26
4	49	M	80	38
5	75	M	57	40
6	61	M	51	43
7	5½	F	42	20
8	¾	F	22	17
9	0*	F	6	6
10	63	F	43	37
11	44	M	38	38
12	72	M	71	64
13	35	M	44	36
14	1¼	F	22	19
15	45	M	57	42
16	56	F	40	37
17	58	M	40	38
18	1	M	23	19
19	35	F	53	37
20	94	M	60	37

*Premature infant, 6 months' gestation

tomosis as reported by Rudler. This complication occurred in such a high percentage of cases that it would seem to be a valid objection to the use of the colon for this purpose. It must be pointed out, however, that these fistulas occurred in somewhat debilitated subjects in whom the power of healing may have been impaired. In view of the good healing of the esophagocolic anastomosis obtained in dogs, it appears that if the patient received adequate nourishment with particular reference to protein and vitamins and if the colon were treated preoperatively by chemotherapy, healing without fistula formation should result in most instances.

The intrathoracic esophagoplasty has several points of superiority over the antethoracic. The course of the tube is not curved or kinked in the intrathoracic as it is in the extrathoracic esophagus. The blood supply to the transplanted tube is less likely to become impeded within the chest than it is in the extrathoracic location. The cosmetic result is better in the intrathoracic esophagoplasty. There is a more nearly normal restoration of the deglutition process in intrathoracic esophagoplasty. The intrathoracic esophagoplasty is less vulnerable to external trauma than the subcutaneously placed one.

Esophagoplasty by mobilization of the stomach and gastroesophagostomy sometimes results in disturbed physiology and discomfort to the patient. The patient often must sleep and rest in a semisitting position rather than in the horizontal, to allow food to fall by gravity toward the duodenum and to prevent regurgitation. Total replacement of the esophagus is sometimes accomplished with difficulty owing to shortness of the stomach and to tension on the esophagogastric anastomosis. In some cases, it may be technically impossible to replace the entire esophagus by the mobilized stomach.

PROPOSED RIGHT COLONIC INTRATHORACIC ISOPERISTALTIC ESOPHAGOPLASTY

Anatomical considerations pertaining to the use of the right colon in man for esophageal substitution have been evaluated in human cadavers.

The right colon was measured post mortem in 20 subjects and found to be adequate in length for a total esophagoplasty. Table II shows the measured length of the right colon compared to the distance between the mastoid process and the xiphoid process. It will be seen that the length of the right colon bears no constant relationship to this distance, which is at least as great as the length of the esophagus. However, in no case was the length of the right colon less than the xiphoid-mastoid distance. The diameter of the colon is great enough to insure passage of the food bolus without impaction or obstruction. In this respect, one of the disadvantages of esophagocologastrostomy seen in dog experiments is not present in men in whom the lumen of the colon is greater than that of the oral stump of the esophagus.

The right colon is a rather tough structure and is distensible enough to permit its use in esophagogastric replacement in the event that

both stomach and esophagus require resection, as is sometimes the case. The transverse colon has been used as a gastric reservoir following total gastrectomy by Lee. Orsoni and Lemaire found the colon to be a good material for esophageal replacement.

The blood supply to the right colon is relatively constant as compared with the small intestine. It can probably be depended upon to sustain the transplanted section of bowel in nearly every person. The collateral circulation of the human right colon is shown in Figure 8.

Before mobilization of the right colon, the adequacy of collateral circulation to the right colon can be tested by the application of rubber shod bulldog clamps to the right colic and the ileocolic arteries. If the circulation to the right colon via the middle colic artery is adequate after 10 minutes of occlusion, the clamp on the ileocolic artery may be removed and the right colic vessels divided near the root of the mesentery. The vessels to the right colon are so large that adequate collateral circulation is almost assured.

Total intrathoracic replacement of the esophagus by means of the right colon can be performed in one stage through a thoracoabdominal incision, or in two stages, with a second stage for cervical esophagocolostomy. The latter procedure would have the advantage of being safer, since the esophagocolostomy is performed in the neck after the mediastinum has become sealed against possible contamination. Also, it would decrease the operating time of the major procedure. The one stage procedure would have the advantage that a tube could be passed through the new esophagus into the stomach for evacuation and feeding.

The following procedure is proposed for intrathoracic esophagocologastrostomy: Incision is made through the bed of the seventh rib or the seventh intercostal space and carried forward across the costal cartilage onto the abdomen where it reaches the midline just above the umbilicus. If necessary, to expose the cecal region, the incision can be extended further to the right, or downward as a right rectus component of the long oblique incision.

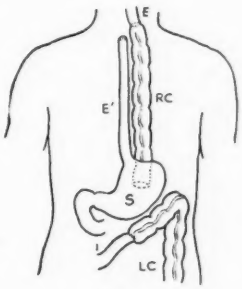

Fig. 9.

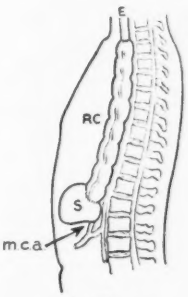

Fig. 10.

Fig. 9. Diagram (anterior view) of proposed esophagocologastrostomy: *E*, esophagus; E^1, aboral portion of esophagus (unresected); *RC*, right colon; *S*, stomach; *I*, ileum; *LC*, left colon.

Fig. 10. Diagram (left lateral view) of proposed esophagocologastrostomy: *E*, oral stump of esophagus; *RC*, right colon; *S*, stomach; *m.c.a.*, middle colic artery.

The first intra-abdominal procedure is measurement of the amount of colon that will be required for total replacement of the esophagus. The colonic circulation is next tested if the right colon is found to be suitable in length for the replacement.

The transverse colon is then divided between clamps at the point where the middle colic vessels approach nearest to the bowel. The ascending colon is then severed between clamps, so that sufficient length of right colon is allowed for the esophagoplasty. The aboral end of the ascending colon just severed is closed by inversion. The proximal end is joined to the aboral end of the transverse colon by end-to-end anastomosis. If this is not feasible, the cecum is resected and a left ileocolostomy is performed. The proximal stump of the colon is anastomosed to the stomach as high as possible on its posterior wall. Tension on the middle colic vessels is to be avoided.

The right colon is then brought up through the diaphragm into the posterior part of the left thorax and an esophagocolic anastomosis is performed. No redundancy should be permitted, unless the vessels do not allow the colon to be stretched into a straight tube. The colon is then anchored to the parieties by interrupted sutures between the mesentery or the retroperitoneal surface and the pleura near where the esophagus has been removed.

The diaphragm is closed snugly about the colon, fixed to the latter by interrupted vertical sutures passing into the tenia coli.

Figures 9 and 10 illustrate diagrammatically the proposed reconstruction of the human esophagus by means of a right colic transplant.

Care is taken not to leave any defect in the mesentery where the ileocolostomy is performed, through which an internal hernia might occur. The mesentery attached to the middle colic vessels should be sutured to the parietal peritoneum for the purpose of preventing herniation under the vessels.

SUMMARY.

The right colon of the dog is unsatisfactory as a substitute for the esophagus. Its length is too short for a total esophagoplasty. Its lumen is too small to permit large boluses of food to pass through to the stomach. The vascular supply of the right colon in the dog is not always dependable after ligation of the right colic and ileocecocolic arteries. However, healing of the anastomosis of colon and esophagus was satisfactory. Peristalsis was seen in the intrathoracic colic segment.

Defects have been noted in all types of esophagoplasty currently employed. The intrathoracic esophagoplasty has advantages not possessed by antethoracic methods.

Objections to the use of the right colon for esophagoplasty in the dog are not applicable to the right colon in man. An outline of a proposed right colon esophagoplasty in man is presented.

It is not proposed that esophagocologastrostomy supplant esophagogastrostomy, which is currently the operation of choice following most esophageal resections, especially for cancer. However, it may be a preferable operation in certain cases of benign lesions of the esophagus, such as strictures and tracheoesophageal fistulas which cannot be adequately treated by primary anastomosis.

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THE MOVEMENT OF POTASSIUM DURING EXPERIMENTAL ACIDOSIS AND ALKALOSIS IN THE NEPHRECTOMIZED DOG

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THE experiments described herein were originally planned to study the behavior of extracellular electrolytes, especially potassium, following various types of intravenous infusion. The concentration of the various ions in the plasma was measured directly. The volume distribution of Evans' blue dye (T 1824) and sucrose was used to measure plasma and extracellular fluid (ECF) spaces respectively. Because the size and content of the ECF were extensively altered both by the movement of fluid through the cell wall as well as by renal activity, the latter variable was eliminated by performing a bilateral nephrectomy before the start of each acute experiment. By thus excluding the renal factor, one could attribute observed changes in the volume distribution of Evans' blue dye and sucrose to contributions to the ECF from the intracellular fluid (ICF). A uniform pattern was found in which potassium entered cells during infusions of sodium bicarbonate and left cells during the infusion of sodium or ammonium chloride.

PREVIOUS WORK

Clinically, acid-base disturbances and potassium deficiency are frequently associated with changes in the body's fluid content. Notable is the association of alkalosis and hypokaliemia with ECF deficits induced by vomiting and the acidosis and hypokaliemia observed with the dehydration of uncontrolled diabetes. In dehydrated infants with severe diarrhea Darrow was probably the first to draw attention to the existence of potassium deficiency. Later potassium deficiency was observed in patients with pyloric obstruction and after operation.

In the classic study of electrolyte disturbances in diabetic acidosis by Atchley and coworkers, larger losses of potassium and phosphate were found than could be accounted for by intracellular tissue breakdown. Subsequently the relation of potassium loss in acidosis to clinical manifestations and its importance in therapy was clearly established.

Experiments describing simultaneous changes in potassium and hydrogen ion concentrations have been relatively few. A preliminary report of the findings on this subject as herein described was given in 1950 at a meeting of the American College of Surgeons (10). More recently, Abrams, Lewis, and Bellet reported that while hydrogen ion concentration was increasing, plasma potassium concentration rose and that while the hydrogen concentration was decreasing, the plasma potassium concentration fell, both in normal and in potassium-depleted dogs. In their experiments the hydrogen ion concentration changes were induced by the administration of ammonium chloride and sodium bicarbonate. These findings were obtained in animals with intact kidneys. Elkinton and Winkler in 1944 showed that potassium moves into the ECF presumably from the ICF following the intravenous infusion of hypertonic saline. They noticed a similar movement in human beings following the ingestion of dry sodium chloride, and in dogs following the ingestion of hypertonic sodium sulfate.

EXPERIMENTAL PROCEDURE

Each experiment was approximately of 8 hours' duration and was divided into two periods. The first consisted of a 2 to 4 hour control period which immediately followed a

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Aided by a grant (RG-2402) from the United States Public Health Service.

TABLE I.—CHANGES IN EXTRACELLULAR FLUID VOLUME

Exp. No. (B.w. in kgm.)	Before infusion	Infusion		After inf.	Difference	Maximum change in	
		Kind	Amt.			Hematocrit per cent	Total protein (gm. per cent)
1(12.5)	2.0	NaCl	1.0	4.1	+1.1	46–21	6.5–3.4
2(14.4)	2.4	NaCl	1.0	4.2	+ .8	44–31	6.2–4.1
3(20.3)	2.3	NaCl	1.0	3.9	+ .6	45–30	7.2–4.2
4(18.0)	2.8	NaCl	1.0	3.9	+ .1	56–30	7.2–4.2
17(15.8)	4.0	NH_4Cl	0.6	4.6	0	36–35	4.9–4.7
5(15.4)	3.2	Glucose	1.0	4.0	− .2	36–38	5.8–5.0
6(8.2)	1.4	$NaHCO_3$	0.7	2.3	+ .2	44–35	4.7–3.7
8(9.1)	1.5	$NaHCO_3$	0.7	2.5	+ .3	48–40	5.8–4.2
9(12.5)	2.4	KCl	0.09	2.5	0	42–46	7.3–7.5
11(12.6)	2.1	KCl+NaCl	1.0	3.2	+ .1	43–33	5.5–3.5
10(9.6)	1.6	KCl+$NaHCO_3$	0.6	2.2	0	44–42	4.8–4.0
12(12.7)	2.4	KCl+$NaHCO_3$	1.0	3.5	+ .1	37–32	4.9–3.8
13(8.5)	2.3	KCl+$NaHCO_3$	?	3.6	?	35–25	4.7–3.3
14(16.7)	3.4	KCl+$NaHCO_3$	1.1	4.6	+ .1	36–31	4.5–3.6
16(18.0)	3.2	KCl+$NaHCO_3$	1.2	4.4	0	52–36	3.6–2.8
18(14.2)	2.8	NaCl (5%)	.2	3.9	+1.1	30–22	6.6–5.3

All values, except where indicated, in liters.

bilateral nephrectomy performed under nembutal anesthesia; the second, a loading period of 4 hours when the effects of the infusions were studied. At the beginning of each experiment a No. 15 spinal needle with obdurator and blunt point was inserted into the external jugular vein toward the heart. Through it light anesthesia was maintained by the addition of small doses of nembutal from time to time. In addition, 0.5 to 1.0 milliliter of heparin solution was introduced approximately every 2 hours.

Blood volume and ECF volume determinations were carried out with injections of Evans' blue (T 1824) and sucrose respectively, following which at least 3 samples of venous blood were drawn through the cannula at appropriate intervals. These were collected in detergent and acid washed heparinized test tubes. The experimental solution was then infused through the same jugular cannula. Following this, additional doses of T 1824 and sucrose were given at intervals over the subsequent 4 to 8 hours and at least 4 more heparinized blood samples were drawn for determination of the concentration of T 1824, of sucrose, and of sodium, potassium, phosphate, calcium, chloride, carbon dioxide, and other measurements. Two simultaneous samples were taken, one for whole blood measurements, the other under oil for plasma analysis. The whole blood aliquot was subjected to the following measurements: hematocrit, using a Wintrobe tube; water by drying to constant weight; sodium and potassium by means of the Weichselbaum-Varney flame photometer (17). Plasma was analyzed separately from the anaerobically collected samples and analyzed as follows: *p*H by the Van Slyke spectrophotometric method (17), carbon dioxide content by the Van Slyke manometric apparatus, water by drying to constant weight, sodium, potassium, and calcium by the Weichselbaum-Varney flame photometer (18), inorganic phosphorus by the method of Fiske and Subbarow, adapted to the spectrophotometer, chloride by the method of Van Slyke and Hiller (15), total and fractional plasma proteins by the method of Weichselbaum (19), glucose by the Somogyi-Nelson method (12), sucrose according to a colorimetric method of Weichselbaum (19), blood volume with T 1824 according to the extraction method of Crooke and Morris.

The infusions (with 2 exceptions) consisted of about 1 liter made up as isotonic solutions containing either sodium chloride, sodium bicarbonate, glucose, sodium chloride with potassium chloride, sodium bicarbonate plus potassium chloride, or ammonium chloride given at a rate of 200 to 400 milliliters per kilogram per hour. The 2 exceptions were a 90 milliliter infusion of isotonic potassium chloride and a 200 milliliter infusion of 5 per cent sodium chloride. At least 15 minutes were allowed after the conclusion of each infusion for thorough mixing before determinations were started.

In all, 16 experiments were carried out as follows (see Tables I and II):

a. Four experiments (1, 2, 3, 4)—Infusion of sodium chloride
b. One experiment (17)—Infusion of ammonium chloride
c. One experiment (5)—Infusion of 5 per cent glucose
d. Two experiments (6, 8)—Infusion of sodium bicarbonate
e. One experiment (9)—Infusion of potassium chloride alone
f. One experiment (11)—Infusion of potassium chloride with sodium chloride
g. Five experiments (10, 12, 13, 14, 16)—Infusion of potassium chloride with sodium bicarbonate
h. One experiment (18)—Infusion of 5 per cent sodium chloride

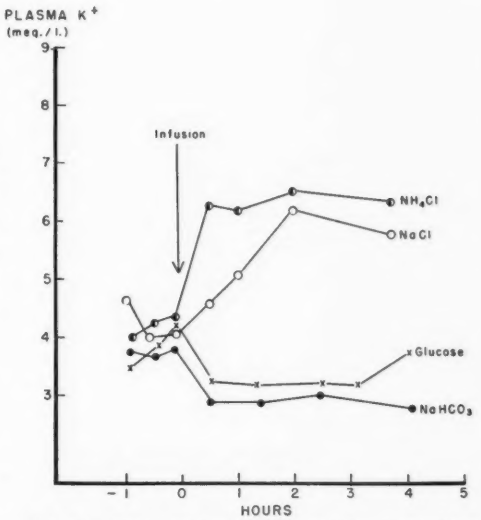

Fig. 1. Effect of various infusions on plasma potassium level. Note the prompt and pronounced increase in the plasma potassium concentration with sodium chloride and with ammonium chloride, the prompt but slight fall with both glucose and with sodium bicarbonate. These differences can be correlated with changes in the acid-base balance as shown in Table II.

In the experiments illustrated in Figures 1, 2, and 3, infusions were started intravenously at 0 time shortly after bilateral nephrectomy and lasted 15 to 30 minutes. All solutions were isotonic and were 600 to 1,000 milliliters in volume (except when KCl was given alone).

FINDINGS

From the many determinations made in these experiments the following will be discussed—ECF measurements, i.e., sucrose space, the effects of each solution, changes in red blood cells.

Extracellular fluid measurements. ECF as determined by the volume of distribution of sucrose gave an initial value ranging between 16 and 20 per cent of the body weight (Table I). These findings agree well with the values recently obtained with inulin and a constant infusion technique. In most of the present experiments, the ECF measured after the infusion agreed fairly well with the expected increase resulting from the known volume of the infused fluid. The discrepancy varied from 0 to 300 milliliters. However, in the first 3 experiments (Table I) with sodium chloride, the difference was more marked, i.e., the measured value was 1.0, 0.8, and 0.6 liter too high. Similar discrepancies have been noted by Crawford and Gaudino in dog and man following sodium chloride infusion and the use of inulin to measure ECF.

A progressive increase in volume was noted in successive determinations of ECF in most dogs as the experiment continued. This was probably due to the ability of the dog to metabolize sucrose, yielding a value indicating a higher space. This tendency was greatly minimized by injecting further amounts of sucrose. It is of interest to note that inulin, which is preferred by some to sucrose, also disappears in the nephrectomized dog. Nevertheless, these small increases, similar in degree and direction in all experiments, did not prevent satisfactory inferences.

The increase in ECF following infusion was accompanied by a more or less parallel rise in plasma volume and fall in hematocrit and

TABLE II.—CHANGES IN TOTAL POTASSIUM IN EXTRACELLULAR FLUID

Exp. No.	Infusion	K^+ Start (mEq.)	K^+ Added (mEq.)	Theoretic K^+ end (mEq.)	Actual K^+ end (mEq.)	Difference (mEq.)	Maximum changes in	
							plasma *p*H	CO_2 content (mEq./L.)
1	NaCl	7.7	0	7.7	*13	+ 5.6	−.41	− 9.0
2	NaCl	9.6	0	9.6	*23.6	+14.0	—	—
3	NaCl	7.3	0	7.3	*19.2	+11.9	—	0
4	NaCl	9.2	0	9.2	18.3	+ 9.1	−.1	− 5.0
17	NH_4Cl	17.0	0	17.0	33.3	+16.3	−.3	−12.1
5	Glucose	13.2	0	13.2	14.2	+ 1.0	−.35	− 6.9
6	$NaHCO_3$	5.7	0	5.7	6.8	+ 1.1	+.21	+19.3
8	$NaHCO_4$	5.4	0	5.4	6.5	+ 1.1	+.26	+21.9
9	KCl	9.1	15.1	24.2	24.2	0	0	− 4.4
11	KCl+NaCl	9.6	15.0	24.6	28.0	+ 3.4	0	− 7.2
10	KCl+$NaHCO_3$	6.1	9.0	15.1	8.3	− 6.8	+.21	+13.7
12*	KCl+$NaHCO_3$	9.8	13.0	22.8	12.8	−10.0	+.20	+16.0
13	KCl+$NaHCO_3$	9.0	15.0	24.0	13.3	−10.7	+.23	+18.3
14	KCl+$NaHCO_3$	14.8	10	24.8	21.5	− 3.3	+.26	+10.5
16	KCl+$NaHCO_3$	13.7	15	28.7	23.4	− 5.3	+.23	+18.0
18	5% NaCl	12.5	0	12.5	22.3	+ 9.8	−.20	− 4.3

*These values are probably too high because the increase in the measured extracellular fluid volume was greater than the amount infused (see Table I). If the extracellular fluid volume values were corrected to represent merely the increase due to the volume of the infusion, the values would be 10.2, 19.0, 16.4, which would still show a positive though less pronounced difference.

plasma protein concentration (see Table I). Despite this fall in plasma protein concentration, the total protein content of the plasma was increased. This response to saline infusion has been described in detail by Stewart and Rourke, and by Harroun and associates, and indicates the entrance of plasma protein from some source outside the blood stream.

Experiment 18 in which 200 milliliters of 5 per cent sodium chloride was infused showed a change in the ECF of 1.2 liters, or of 1 liter more than the amount infused. The following calculation indicates close agreement between the actual and calculated change in ECF. Thus previous to injection the sodium concentration in the ECF was 151 milliequivalents per liter, and since the sucrose space was 3.15 liters, the total sodium content of the ECF was 475 milliequivalents. The sodium ion added as sodium chloride was 171 milliequivalents which when added to 475 gives a total expected content in the ECF of 646 milliequivalents of sodium. The actual sodium concentration of the ECF after infusion was 161 milliequivalents per liter. Dividing the total sodium of 646 by this figure would give an expected ECF of 4.01 liters; actually 4.30 liters were measured.

The effect of saline solution. In 4 experiments, isotonic saline was infused and in all of these, sodium concentration remained constant. In all, the chloride concentration rose an average of 8 milliequivalents per liter, the bicarbonate concentration fell 5 to 9 milliequivalents per liter. There was also a fall in the *p*H of plasma of 0.1 to 0.4 (Table II).

Associated with the saline infusion *significant* increases in the plasma potassium concentration occurred, as shown in Figure 1 and in the total calculated ECF potassium, as shown in Table II. This indicated that under the conditions of this experiment (in which the plasma hydrogen ion concentration increased) potassium left the ICF and entered the ECF. This change is particularly striking if one compares these findings after saline solution with the glucose experiment in which there was no change in plasma hydrogen ion concentration and practically no change in the total ECF potassium, despite a slight fall in the potassium concentration due to simple dilution. Moreover, in the experiment in

which potassium chloride alone was given, the rise in the total ECF potassium content was exactly that infused. For example, in one experiment 15 milliequivalents of potassium were injected in a volume of 90 milliliters. Previous to this infusion the total ECF potassium was 9.2 milliequivalents (2.4 liters × 3.8). After this infusion the total ECF potassium was 25.6 milliequivalents (2.7 liters × 9.2). Subtracting 25.6 from 9.2 one gets a difference of 16.4 milliequivalents, which is to be compared with the 15 milliequivalents actually added.

The changes in experiment 18 in which 5 per cent sodium chloride was infused are of special interest in that cell water evidently passed into the extracellular space in order to maintain normal osmotic relationships. This inflow of water was accompanied by an increase of nearly 10 milliequivalents in the total potassium content of the ECF space with an increase in concentration from 4.1 to 5.5 milliequivalents per liter (Table II). In addition there was a fall in *p*H of 0.2 unit and in the carbon dioxide content of 4.3 milliequivalents per liter. Similar experiments with hypertonic saline were carried out by Elkinton and Winkler, who demonstrated a definite shift of potassium from the ICF to the ECF, as shown by an increased potassium output in the urine. They also performed experiments in animals with the ureters ligated, and found an increase in the plasma potassium concentration.

The effect of sodium bicarbonate solution. The findings in this group were in contrast to the previous observations. The chloride concentration fell as the concentration of bicarbonate rose. The potassium concentration fell, but the total amount of potassium in the ECF remained relatively unchanged (Table II) because each changed reciprocally. The difference in the changes in concentration of potassium following the infusion of sodium chloride alone and of sodium bicarbonate alone is shown in Figure 1.

The effect of potassium chloride. Because the kidneys were removed, infused potassium could not be excreted and thus one would expect the concentration as well as the total amount of potassium to increase in these experiments by the amount actually infused. This was indeed the case when potassium chloride was given alone as in experiment 9. The danger of infusing potassium chloride after nephrectomy was soon encountered, for of 6 such dogs, 5 died with cardiac arrest. The only survival was the one presented as experiment 9. When potassium chloride was added to a solution of sodium chloride, a similar phenomenon was observed in that 2 out of 5 dogs died of cardiac arrest. However, when potassium chloride was added to sodium bicarbonate, not a single fatality ensued. Striking differences in the two groups were also observed in the plasma potassium concentration as well as in the total potassium of the ECF, as shown in Figure 2 and Table II respectively.

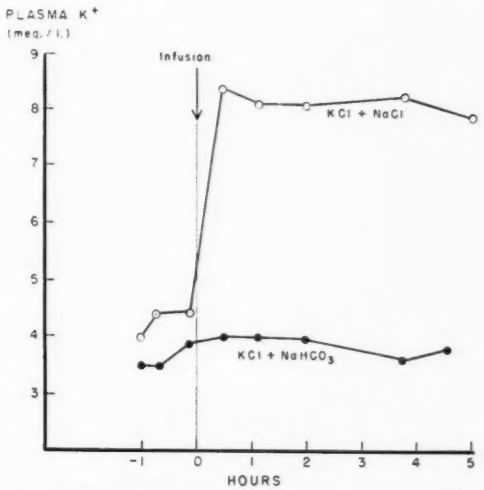

Fig. 2. Effect of infusions of potassium chloride with sodium chloride and with sodium bicarbonate on plasma potassium level. Note the striking rise in the plasma potassium level when potassium chloride was infused with sodium chloride, the absence of any rise when the same amount of potassium chloride was given with sodium bicarbonate. Indeed, cardiac arrest was observed in 3 out of 5 experiments with sodium chloride, none with sodium bicarbonate (see text).

In experiments 14 and 16, potassium chloride and sodium bicarbonate were infused separately. One of these experiments is illustrated in Figure 3, showing the beginning of the increase in the plasma potassium concentration following the infusion of potassium

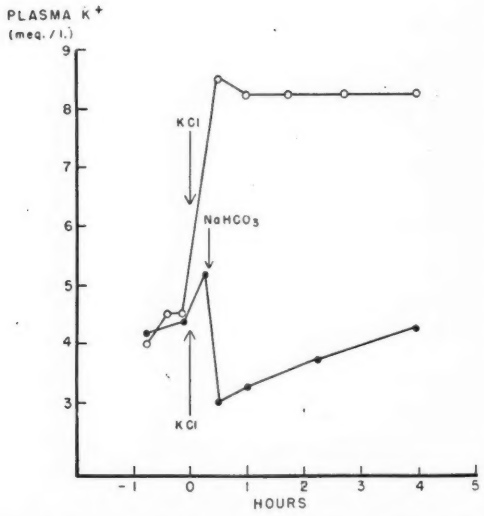

Fig. 3. Effect of infusion of sodium bicarbonate on hyperkaliemia induced by potassium chloride. Note the prompt and persistent increase in plasma potassium level when potassium chloride alone was infused (upper curve). The same infusion was given in the second experiment. Note the rise of plasma potassium 15 minutes later, but its prompt fall 15 minutes after sodium bicarbonate was infused as indicated (lower curve).

chloride, and its prompt fall as soon as the infusion of sodium bicarbonate was started and finished. The data on total amount of potassium in these experiments are listed in Table II.

The effect of ammonium chloride. In view of the obvious influence of acid-base changes on the behavior of potassium, one experiment (No. 17) was carried out in which an isotonic solution of ammonium chloride was infused, and here the results show an accumulation of potassium in the extracellular space similar to that which occurs with the infusion of sodium chloride, except that, as was expected, the difference was much more marked. Indeed, as shown in Table II, the amount of potassium in the extracellular space doubled, obviously being due to the movement of potassium from the intracellular space through the cell wall. Attempts to infuse potassium chloride added to ammonium chloride were uniformly unsuccessful in that cardiac arrest always occurred.

Changes in the red blood cells. Determinations of potassium concentrations in the red cells were carried out in all experiments in order to determine whether there was any shift between plasma and red cells. The calculations were carried out and derived from (a) plasma volume, (b) hematocrit, (c) plasma potassium, (d) whole blood potassium. There was no significant change in the total red cell potassium after the various infusions. Increases or decreases in the ECF potassium could, therefore, be interpreted as being due to a decrease or increase of the ICF potassium respectively. It is suggested these changes occurred through the muscle cell walls and bone.

COMMENT

The present findings suggest that during acute alkalosis induced by the injection of sodium bicarbonate, potassium moves from the ECF to the ICF, whereas during acute acidosis produced by the injection of sodium chloride or ammonium chloride the potassium ion moves into the ECF. To be sure, the acidosis associated with the sodium chloride infusion was only moderate. However, when more marked acidosis was produced with ammonium chloride, the movement of potassium into the ECF was more striking than it was during the infusion of sodium chloride. The most convincing evidence of the influence of acid-base balance on the movement of potassium was obtained when potassium chloride itself was infused, on the one hand with sodium chloride (experiment 11), on the other hand with sodium bicarbonate (experiments 10, 12, 13, 14, 16).

Failure to observe any shifts of potassium into or out of the red cells in the present experiments does not indicate that such shifts will not occur in man. As is well known, there is very little difference between potassium concentration of red cells and of plasma in the dog, as compared with significant differences in the human. However, the measurements made in the present experiments did show that the shifts in potassium which were observed in the ECF did not involve transfers in or out of red cells, and therefore must have occurred in other tissues of the body, presumably muscle or bone or both.

The production of acidosis by the infusion of isotonic saline solution has been previously

reported by many authors, even in experiments in which the kidney was intact. The best probable explanation for this phenomenon is that offered by Van Slyke (16), who called it "dilution acidosis." This refers to the dilution of bicarbonate ions produced by the infusion of sodium chloride. Inasmuch as carbon dioxide is constantly produced by the body tissues, such a dilution will affect only the bicarbonate, diminishing its concentration. This produces a change in the bicarbonate-carbonic acid toward the acid side. This phenomenon has been demonstrated by an elegant experiment described by Shires and Holman in which a drop in *p*H from 7.5 to 7.2 was rapidly produced in a resting dog by a massive infusion (1.5 liters in 5 minutes) of isotonic sodium chloride, whereas a similar infusion with balanced saline and bicarbonate solution simulating the composition of plasma produced no change in *p*H. In the present experiments, acidosis was produced with much less massive infusion because the regulating influence of the kidneys had been eliminated.

Granted that acidosis and alkalosis may influence the movement of potassium out of and into the cell respectively, the question arises as to its mechanism. Much speculation can be found in the literature. Perhaps the best known explanation is that described by Darrow. The studies of Guest and Rapoport (8, 9) also throw some light on this perplexing phenomenon. These workers, on the basis of red cell analysis, believe that acid-base changes in the ECF can lead to a reversible breakdown or synthesis inside the cell of high valence, nondiffusible organic phosphate. This leads to an increase or decrease of anion valence equivalence which is followed by an outflow or inflow of diffusible potassium in order to maintain electroneutrality.

The present findings suggest several possible clinical applications, particularly as more knowledge is being obtained of changes in the potassium content of the ECF. One wonders, for example, whether the plasma potassium excess following severe trauma in burns might not perhaps be due to acidosis, and perhaps suggests that the infusion of sodium bicarbonate or lactate might reverse the process, thus enabling potassium to enter the cell. On the other hand, the phenomenon of dilution acidosis may well explain the frequent finding of low carbon dioxide combining power in patients with severe burns after the infusion of large volumes of isotonic sodium chloride, particularly when oliguria or anuria supervenes. It also points up the importance of avoiding the infusion of sodium chloride, or at least the need for substituting for it a more physiological solution containing both sodium chloride and sodium bicarbonate (or lactate) in conditions of acute trauma or indeed, in any patients with oliguria from any cause in which the infusion of sodium chloride is necessary. Although the use of sodium bicarbonate in anuria has had a long history, there is some question as to its efficacy. Perhaps it should be used only to prevent some of the toxic effects of a high plasma potassium level. Further observations are certainly indicated in the attempt to correlate clinically the association between changes in the acid-base balance and the movement of potassium in and out of the cells, particularly when the kidneys are not functioning.

SUMMARY

1. In 16 acute experiments following bilateral nephrectomy in dogs: (a) Acidosis induced by the infusion of isotonic sodium chloride or isotonic ammonium chloride was followed by an increase in the concentration and total amount of extracellular potassium. (b) Alkalosis induced by the infusion of isotonic sodium bicarbonate was followed by a fall in the concentration with little change in the total amount of extracellular potassium. (c) Infusion of isotonic potassium chloride alone or with isotonic sodium chloride is followed by an increase in the plasma potassium concentration. Death from cardiac arrest was so frequent that only 2 experiments were successful. When potassium chloride was infused with ammonium chloride, cardiac arrest was invariable. (d) Infusion of the same amount of isotonic potassium chloride with isotonic sodium bicarbonate was followed by a fall in the concentration of plasma potassium and a diminution in the total amount of extracellular potassium. In 5 successful experiments, cardiac arrest was not observed.

2. It is inferred from these experiments that in the bilaterally nephrectomized dog, potassium moves into the cell during induced alkalosis, out of the cell during induced acidosis.

3. Possible mechanisms involved have been discussed.

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HISTOLOGIC GRADING OF CANCER OF THE UTERINE CERVIX

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HISTOLOGIC grading of cancer of the uterine cervix has been employed with a view to prognosis for more than a generation. This paper is a survey of the methods used, and an evaluation of them.

Virchow's dictum *Omnis cellula e cellula* suggests if all cancer cells come from a common source, one would reasonably expect the appearance of the cells to reflect the clinical behavior of the tumor. Numerous efforts have been made to establish this correlation.

In 1893 Hansemann introduced the term *anaplasia* to denote a lack of differentiation. He believed that there is a direct relationship between the degree of anaplasia and the invasive capacity of a tumor. In general, this concept has been accepted. All of the methods of grading used are ways of estimating and expressing the degree of anaplasia.

The practical object of histologic grading is to predict the outcome of a particular form of treatment, e.g., if a patient is treated with radiation will she be benefited and live for 5 or more years or will she die of her disease? Even a superficial survey of the subject shows that this objective is not possible at present. If the outcome in all cases cannot be predicted, perhaps the outcome in a few can be, i.e., those who will respond very well or very badly to a particular treatment. If realized, this more modest aim would be of practical value.

Since Hansemann's time there have been a number of methods of histologic grading introduced. Schottlander and Kermauner in 1912 suggested the system that has since become standard in many European countries. The tumors are first divided into adenomatous and solid types. The latter is essentially squamous carcinoma but may include certain adenocarcinoma simplex tumors as well. The solid carcinomas are graded as mature (*reife*), semimature (*mittelreife*), and immature (*unreife*). These indicate three degrees of differentiation, and tumors that show more than one type are classified according to the one present in the greatest proportion of tissue. It may be noted that the majority of tumors show more than one type. Broders of the Mayo Clinic in 1920 and 1922 developed a method that divides the tumor into differentiated and undifferentiated parts and then according to the relative amount of the two types it is assigned to one of four grades. In actual practice the most differentiated, i.e., grade 1, almost never occurs in cervical lesions. Broders originally developed his method for carcinoma of the lip and subsequently applied it to other forms of carcinoma. In North America it is the most commonly used method of classifying carcinoma of all sites.

Martzloff at Johns Hopkins in 1923 to 1927 published a system similar to that of Schottlander and Kermauner in which there were three different degrees of differentiation related to successively more mature layers of the normal cervical epithelium. The predominant cell type determines the grade. Both Broders' and Martzloff's classifications have been widely employed. Healy and Cutler at Memorial Hospital in New York, Chambers at the Marie Curie Hospital in London, and Truelsen and Bang at the Radium Center in Copenhagen have introduced methods of grading that are somewhat similar. Glucksmann and Spear divided their cases into two groups, a small one of differentiated and a larger one of anaplastic tumors. The characteristics of these methods of grading are summarized in Table I.

With the exception noted for Schottlander and Kermauner these methods apply to epidermoid (squamous) carcinoma. The adenocarcinomas are segregated in another category and usually are not graded.

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TABLE I.—HISTOLOGIC CLASSIFICATION OF CARCINOMA OF THE CERVIX

Author	Grade and its relative frequency (per cent)		Characteristics of grade
Schottlander and Kermauner 1912	1 Mature (reife)	10	Prickle cell (riffzellen) predominates
	2 Semimature (mittelreife)	42	Polyagonal cell with well preserved cell membrane
	3 Immature (unreife)	47	Small, round, or ovoid cell or completely irregular types without any evidence of keratinization
Martzloff 1923	Spinal	22	Similar to cells in the upper portion of the stratum mucosum. Polyhedral cells with abundant, pale, well defined cytoplasm
	Transitional	66	Similar to cells between the spinal and the germinativum layers of mucosa. Dark, closely packed nuclei and scanty, deeply staining eosinophilic cytoplasm
	Fat spindle	12	Similar to cells in the stratum germinativum. Very dark nuclei with scanty cytoplasm
Broders 1922–1940	1		Undifferentiated cells, per cent 0– 25 — Differentiated, per cent 75–100
	2	15	25– 50 — 50– 75
	3	48	50– 75 — 25– 50
	4	36	75–100 — 0– 25 Differentiation is characterized by keratinization with large flat squamous cells and small nuclei
Warren and Gates 1931 1934	1 Low malignancy	27	There is an arbitrary division into three categories. The grade is determined by the least differentiated portion of the tumor, but at least ⅕ of the tumor must be involved. Anaplasia is related to: degree of absence of keratinization, increased mitotic activity, abnormal mitosis, variation in cell size, and tendency of the tumor to infiltrate the tissue. When these attributes are seen the tumor is regarded as being highly malignant
	2 Medium malignancy	52	
	3 High malignancy	21	
Healy and Cutler 1928	1 Adult type	17	Highly differentiated, definite squamous tendency. Cornification and pearl formation
	2 Plexiform	62	Squamous character is slight or absent. No diffuse infiltration, partial loss of polarity. Cells large and frequently show a plexiform arrangement
	3 Anaplastic	21	No differentiation, diffuse infiltration, cells small, round or spindle, marked hyperchromatism of nucleus, many atypical mitoses
Chambers 1935	1 Adult type	15	Squames, pearls, and basal cells
	2 Spindle	9	Thin spindle cells resembling those of basal germinating layer
	3 Transitional	54	Clear tendency to form a stratified epithelium
	a. keratinized		Sheets of squames, may be in whorls
	b. differentiated		Squames without keratinization or large vacuolated cells. Basal cell layer usually present
	c. transitional		Most like the normal epithelium of cervix. Basal layer distinct, gradual change from transitional to spindle
	d. anaplastic		Loss of squamous character, deep staining cells with mitoses in all layers
	4 Anaplastic	22	No formation of stratification, no squamous character active growth, round or fat spindle shaped cells with deep staining nuclei and common mitoses
	a. alveolar		Significant amount of intervening tissue between masses of tumor
	b. solid		Solid mass with little intervening tissue
Truelsen and Bang 1949	1 Parakeratotic	53	Highly differentiated cornifying squamous cells with epithelial pearls and numerous spinocellular elements
	2 Squamous cell mucosal type	29	Similar to mucosal layer, with numerous "elder marrow" cells
	3 Undifferentiated	9	Highly anaplastic polymorphous cells without differentiation
	4 Basal cell	9	Similar to the basal cell layer, undifferentiated
Glucksmann and Spear 1945	AS, anaplastic squamous	27	When young, they resemble basal cells, on growing old they undergo keratinization
	AP, anaplastic parakeratotic	73	Highly anaplastic, with virtually no differentiation. Degenerate by cytoplasmic condensation (parakeratosis) or by nuclear disintegration

TABLE II.—DISTRIBUTION OF CASES OF SQUAMOUS CELL CARCINOMA ACCORDING TO THE HISTOLOGIC CLASSIFICATION

	Total No. cases	Per cent			
		Grade			
		1	2	3	4
Schottlander and Kermauner 1912	115	11	41	48	
Kamniker (S & K) 1932	229	8	33	59	
Reichenmiller et al. (S & K) 1948	597	—	33	67	
Martzloff 1927	366	16	71	13	
Pemberton (M) 1926	62	37	54	9	
Kimbrough and Norris (M) 1927	48	52	27	21	
Maliphant (M) 1933	226	31	56	13	
van Gulik (M) 1939	180	36	58	6	
Broders (Mayo Clinic) 1922	269		9	57	34
Bowing (Mayo Clinic) (B) 1949	1357	0.7	15	48	36
Warren (B) 1931	85	27	52	21	
Gates and Warren (B) 1934	1422	25	52	23	
Morris and Meigs (B) 1950	1558	12	42	38	8
Healy and Cutler 1928	200	17	62	21	
Wetterdal (H & C) 1934	354	46	44	10	
Chambers 1935	222	14	12	59	15
Truelsen 1949	685	51	29	10	10
Glucksmann and Spear 1945	346		25	75	

S & K—Graded according to Schottlander and Kermauner.
M—Graded according to Martzloff.
B—Graded according to Broders.
H & C—Graded according to Healy and Cutler.

There are two inherent difficulties in classifying tumors according to their histologic appearance.

1. The assignment of a given tumor to a particular grade is a rough estimate based on the observer's impression so that from day to day and year to year the same observer may change the grade as applied to the same case. This is not true for the majority of cases but applies to borderline ones. Of greater importance is the difference in interpretation of different observers. Some idea of the agreement between different individuals and also between two successive series in the same clinic is evident in Table II which shows the incidence of the various grades classified according to the same system. It can be seen that there is fairly good agreement between Broders' original series and a later series reported from the same clinic by Bowing. Warren (23) also shows consistent results in two series, the later one in association with Gates. The remainder of the material shows comparatively little agreement between individuals using the same system or between the various systems.

TABLE III.—THE INCIDENCE OF CLINICALLY LIMITED DISEASE (STAGES I AND II) IN THE MOST DIFFERENTIATED GRADE AND IN THE MOST ANAPLASTIC GRADE*

	Most differentiated		Most anaplastic	
	Total No.	Per cent in stages I and II	Total No.	Per cent in stages I and II
Reichenmiller	196	55	401	57
Maliphant	37	19	21	24
van Gulik	64	62	11	55
Healy and Cutler	35	29	42	21
Wetterdal	163	37	35	51
Chambers	30	13	34	23
Glucksmann and Spear	87	48	259	24
Morris and Meigs	122	55	27	56
Total	734	44	830	42

*Calculated from Table IV.

2. The biopsy is not necessarily a true index of the entire tumor. For example, Martzloff (15) found that one third of the cases failed to show agreement between the biopsy and the entire specimen. Satisfactory prognosis from histologic grading should indicate the clinical course of the patient either untreated or following treatment. If there is a direct relationship between anaplasia and the invasive capacity of the tumor it should be demonstrable in untreated cases by a shorter duration of life measured from onset of symptoms in the anaplastic growths than in those more differentiated, but we are not aware of a series of neoplasms of the cervix where this correlation has been carried out.

If anaplasia is an index of invasiveness, one would expect some correlation with the clinical extent of disease, i. e., there should be more grade 1's in the stage I's and more grade 3's or 4's in stage III's or IV's. In Table III the incidence of stages I and II combined is calculated: (a) in the most differentiated, and

TABLE IV.—CURE RATE BY HISTOLOGIC GRADE IN LIMITED (STAGES I AND II) AND ADVANCED (STAGES III AND IV) TUMORS

		Grade 1			Grade 2			Grade 3			Grade 4			Adeno			Total		
		Total No.	No. cure	Per cent cure	Total No.	No. cure	Per cent cure	Total No.	No. cure	Per cent cure	Total No.	No. cure	Per cent cure	Total No.	No. cure	Per cent cure	Total No.	No. cure	Per cent cure
Stages I and II*																			
Reichenmiller† 1948	1932–1939				107	64	60	231	98	42				21	11	52	359	173	48
Maliphant‡ 1933		7	3	43	20	7	35	5	2	40				2	1	50	34	13	38
van Gulik 1939	1922–1923	40	22	55	72	34	47	6	3	50							118	59	50
Healy and Cutler 1928		10	5	50	21	9	39	9	6	66							40	20	50
Wetterdal 1934	1926–1930	60	24	40	68	25	37	18	8	44							146	57	39
Chambers‡ 1935	1926–1929	4	3	75	10	8	80	40	31	78	7	4	57	12	8	66	73	54	74
Glucksmann and Spear 1945	1930–1939				42	16	38	63	17	26							105	33	31
Stages III and IV*																			
Reichenmiller† 1948	1932–1939				89	21	24	170	27	16				8	0	0	267	48	18
Maliphant‡ 1933		30	3	10	66	4	6	16	2	12				5	1	20	117	10	8
van Gulik 1939	1922–1923	24	13	12	33	4	12	5	0	0							62	7	11
Healy and Cutler 1928		25	1	4	102	15	15	33	14	42							160	30	19
Wetterdal 1934	1926–1930	103	12	12	88	13	15	17	1	6							208	26	12
Chambers† 1935	1926–1929	26	10	38	17	6	35	91	33	36	27	10	37	19	10	53	180	59	33
Glucksmann and Spear 1945	1930–1939				45	12	27	196	23	12							241	35	14

* International classification.
† Stage IV's are excluded.
‡ 3 year "cure".

TABLE V.—CORRELATION OF HISTOLOGIC GRADE OF TUMOR WITH METASTASIS 132 AUTOPSY CASES FROM WARREN, 1933

Grade	No. of cases	Regional metastases to nodes* No.	Regional metastases to nodes* Per cent	Without metastases* No.	Without metastases* Per cent
Epidermoid ca. I	25	10	40	15	60
Epidermoid ca. II	66	46	70	17	26
Epidermoid ca. III	21	17	81	3	14
Epidermoid ? grade	4			4	100
Adenoacanthoma	5	5	100		
Adenocarcinoma	11	6	55	1	9
Total	132	84	64	40	30

*The patients with distant metastases are not listed. Thus the sum of the cases in the last two columns does not equal those in the first column.

(b) in the most anaplastic categories for each author and for the combined series. For example, Maliphant had 37 cases of the spinal type listed in Table IV in the grade 1 columns. Of these 37 cases, 7 (19 per cent) are stage I or II. The same author had 21 cases of the *fat spindle* type listed in grade 3 columns and 5 (24 per cent) of them are stage I or II. Thus there is no significant difference between the anaplastic and the differentiated tumors as far as clinical extent is concerned. About one fifth of both are still confined to stage I or II. It is apparent that with the possible exception of Glucksmann's and Spear's group there is little direct correlation. Wetterdal's and Chambers' series show a reverse correlation,

TABLE VI.—HISTOLOGIC GRADING DISTRIBUTION OF CASES AND CURE RATE

	Years of study	No. of cases	Overall cure rate per cent	Treatment	Grade 1		Grade 2		Grade 3		Grade 4		Adeno	
					No. Cases	Cure rate per cent	No. cases	Cure rate per cent	No. cases	Cure rate per cent	No. cases	Cure rate per cent	No. cases	Cure rate per cent
Schottlander and Kermauner 1912		115			12		48		55					
Kamniker 1932 (S & K)	1921–1925	103	47	Surgery	5	40	31	49	59	49	8	37		
Reichenmiller et al. 1948 (S & K)	1932–1939	626	35	Radiation			196	41	401	31			29	38
Martzloff 1927	1893–1920	146	32	Surgery	30	53	90	28	17	12			9	33
Pemberton 1926 (M)	1917–1924	62	19	Radiation and surgery	23	22	34	18	5	20				
Kimbrough and Norris 1927 (M)	1921	54	30	Radiation	25	28	13	25	10	20			6	50
Maliphant 1933 (M)		151	14	Radium	37	13	86	12	21	19			7	29
van Gulik 1939 (M)	1923–1933	180	37	Radiation	64	40	105	36	11	27				
Broders 1922	1904–1915	180	18	Surgery and cautery			15	53	102	22	63	10		
Bowing 1949 (B)	1915–1944	1357			9		205		656		487			
Warren 1931 (B)		99			23		44		18				14	
Warren et al. 1939 (B)		61	36	Radiation	1	0	25	44	32	28			3	66
Morris and Meigs 1950	1927–1942	1660	20	Radiation	122	22	617	20	792	21	27	15	102	23
Healy and Cutler 1928		200	25	Radiation	35	17	123	19	42	48				
Wetterdal 1934 (H & C)	1926–1930	354	23	Radiation	163	22	156	24	35	26				
Chambers 1935	1926–1929	253	33	Radium	30	43	27	52	131	49	34	41	31	58
Truelsen 1949		685	30	Radium	356	23	202	35	65	26	62	23	124	29
Glucksmann and Spear 1939		368	20	Radiation			87	32	259	15			22	

Note:
Reichenmiller et al. do not include stage IV cases, 2—mature, 3—immature.
Maliphant, 3 year survival rate.
Chambers, 3 year cure rate.
Schottlander and Kermauner, 1—mature, 2—semimature, 3—immature.
Glucksmann, 2—anaplastic squamous, 3—anaplastic parakeratotic.
Martzloff, 5 year cure; patient discharged from hospital and followed 5 years; 1—spinal, 2—transitional, 3—spindle cell cancer.
(S & K) graded according to Schottlander & Kermauner.
(M) graded according to Martzloff.
(B) graded according to Broders.
(H & C) graded according to Healy and Cutler.
The remainder are graded according to the system of the author of the report.

i.e., there are more stage I's and II's in the anaplastic grades than in the differentiated ones. In general these data fail to confirm a correlation between anaplasia and invasiveness as demonstrated by the clinical extent of disease.

The incidence of metastasis correlates fairly well with the histologic grade. Warren (24), using a modified Broders system, studied 132 cases at autopsy and found that the differentiated tumors had a relatively lower incidence of metastasis than the anaplastic tumors, but there was no absolute correlation. His findings are summarized in Table V.

The clinical impression of greater anaplasia in the young patient and a more frequent occurrence of well differentiated tumors in the aged is not borne out on closer scrutiny. Actually there is a fairly even distribution of anaplasia and differentiated in all age groups.

The correlation of prognosis with histologic grading is indicated in Tables IV and VI. Anaplastic growths are generally conceded to be more radiosensitive than those more dif-

ferentiated, i.e., they show a more pronounced immediate response to radiation, but the actual cure rate in the anaplastic lesions is somewhat less, as is evident in most of the systems of grading. An exception to this is the report of Healy and Culter where the most anaplastic grades apparently exhibit a better cure rate than the differentiated. The difference in cure rate following radiotherapy in most instances is not sufficient seriously to alter the outlook in the individual case. If the number of cases in the most differentiated grade and those in the most anaplastic grade are totaled separately for the series treated radiologically and included in the seven reports (4, 7, 9, 12, 19, 22, 26), the following figures result: most differentiated grade, a total of 968 cases, 281 (29 per cent) "cured"; most anaplastic grade, a total of 865 cases, 229 (26.5 per cent) "cured." The difference in cure rate between these two groups cannot be regarded as significant.

Martzloff and Broders report two series of cases treated surgically (Table VI) that show rather nice correlation between the degree of differentiation and the cure rate. The most differentiated grades have a 53 per cent cure rate and the most anaplastic, a cure rate of 12 per cent and 10 per cent respectively. These are the most impressive prognostic figures in the entire review and would lead one to believe that in cases treated surgically, histologic grading is significant. However, Kamniker a short time later failed to show any prognostic value in a surgical series at the First University Women's Clinic in Vienna, graded by Schottlander and Kermauner's system. The discrepancy between these results may lie in the technique of grading and reflect superiority of the methods of Broders and Martzloff. We are not aware of a significantly large series of anaplastic tumors treated with surgery in recent years that may be evaluated to prove this point. For example, Meigs has only 2 grade 4 tumors in patients in his radical surgery series treated in the period 1941 to 1945. Both are living and well. During this period 14 grade 4 cases were treated radiologically; 3 were living and well at 5 years.

From these data we may conclude that the histologic grading of cancer of the uterine cervix is of limited value. In the majority of systems the most anaplastic growths have a cure rate one-fourth to one-third lower than that of the most differentiated grade when treated radiologically. Two reports (2, 14) suggest that the surgical results in anaplastic growths are poor and would be better treated radiologically, but another series (10) fails to confirm this impression. Thus further work is required to establish the prognostic significance of histologic grading in surgically treated cases.

SUMMARY

All of the established methods of histologic grading are based on the degree of anaplasia versus differentiation. The various methods are reviewed. The technique is partially subjective and limited by the biopsy which may or may not be a good sample of the tumor.

The degree of anaplasia correlates poorly with the clinical extent of disease when the patient is first seen but somewhat better with the incidence of metastases in postmortem material.

Radiotherapy results in a moderately higher "cure" rate in differentiated tumors than in anaplastic ones. Some results of surgically treated highly anaplastic tumors are poor.

It is concluded that histologic grading is of limited prognostic value in cancer of the cervix.

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THE VALUE OF TRACHEOTOMY IN ACUTELY ILL SURGICAL PATIENTS

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TRACHEOTOMY is a valuable surgical procedure, which has in many instances been neglected as an adjunct to treatment of acutely ill patients. It has been thought of as an emergency, "last resort" procedure in acute respiratory obstruction above the laryngotracheal junction or in chronic conditions, such as carcinoma of the larynx and pharynx, which cause obstruction to the airway. Recently there has been emphasis on the use of tracheotomy in some major surgical procedures about the face and neck. Its use has also been advocated in acute cerebral injuries and in certain cases of chest trauma. Some thoracic surgeons, in the last few years, have been employing tracheotomy routinely as a part of the management of severely ill postoperative patients. However, the importance of this procedure in all branches of surgery has not been adequately stressed.

We have reviewed the records at this hospital with the idea of presenting several representative cases to illustrate some definite indications for tracheotomy. In the period from May, 1948 to June, 1952, a few more than a hundred tracheotomies were performed. This did not include those done in conjunction with laryngectomies and similar procedures performed because of carcinoma or other lesions in the region of the larynx. The surgical service at this hospital includes cases in general surgery and in practically all of the specialty branches of surgery. It has been noted that in many instances when the tracheotomy was finally done, the patient was moribund and expired shortly thereafter. Our plea is for recognition of the need for earlier tracheotomy in such patients and the use of prophylactic tracheotomy in special types of cases in which experience has shown it to be of inestimable value.

In a review of 60 cases of radical neck dissections performed for carcinoma of the head and neck, there were 4 postoperative deaths and it was felt that 3 of these could probably have been prevented had a prophylactic tracheotomy been done on the operating table at the close of the operative procedure. At present that course is followed at this hospital in all cases of radical neck dissection that are combined with any oral operative procedure.

The procedure is a relatively simple one which is tolerated quite well under local anesthesia. Jackson and Jackson have adequately described the operative technique and we have nothing to offer except a preference for a small transverse skin incision with careful attention to hemostasis. This can be carried out very satisfactorily in most patients. In strictly emergency situations, however, where speed is of the greatest importance, a vertical type incision may be more rapidly done. Various types of tracheotomy tubes may be used but all have the same principal.

The primary aim, in the type of case under discussion, is maintenance of an adequate airway. In the acutely ill patient, this may be difficult to do because of the presence of various obstructing materials, which can and do lead to considerable difficulty. The accumulation of secretions from the tracheobronchial tree, per se, aspiration of pharyngeal secretions and saliva, of food or drink during swallowing, of vomitus, and of old blood from wounds about the mouth and nose are all important sources of such material.

If the patient is responsive and has an effective cough, the respiratory tree can be kept clean, particularly with the help of frequent intratracheal suction. However, in many patients with severe illnesses or following serious

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injury or major surgery, the cough is not effective and suction is not adequate. These people very rapidly get into trouble and develop pulmonary complications such as atelectasis, bronchopneumonia, aspiration pneumonia, and lung abscess. In order of simplicity, the following measures to prevent these complications might be listed: (1) encouragement of the patient to cough and to breathe deeply; (2) oral and pharyngeal suction; (3) intratracheal suction; (4) bronchoscopy; (5) intratracheal intubation; and (6) tracheotomy. This list is not to be interpreted as the order in which to treat these patients because circumstances alter each case. In the majority of postoperative cases, the first is sufficient. In most postoperative chest cases intratracheal suction is required in addition. In certain acute traumatic injuries to the head and neck where frequent suctioning is necessary, but the duration is expected to be less than 48 hours, intratracheal intubation may be done. In other cases bronchoscopy performed daily or less often for short intervals is all that is required. However, in numerous patients short interval suctioning is required over prolonged periods and although the methods mentioned may be temporarily adequate, the patient will soon be in trouble again. These are the patients who need a tracheotomy. In such cases tracheotomy should be used relatively early. Experience has shown such a course to be necessary in certain types of patients.

The following cases are presented to illustrate the use of tracheotomy in severely ill patients in several branches of surgery.

CASE 1. Reg. No. 35 671. This was a 20 year old white male soldier who was in an automobile accident and received multiple injuries consisting of severe cerebral contusions and lacerations and a comminuted fracture of the left femur. He was unconscious on admission and in a marked degree of traumatic shock which responded to treatment. There were no localizing neurological findings. Consequently, he was treated conservatively by the neurosurgical staff. On the third hospital day, his temperature became elevated to 104 degrees and he developed a Cheyne-Stokes type respiration. At this time a tracheotomy was done and within a few hours normal respiration was resumed. Thereafter, the patient gradually improved. His cerebral status eventually returned to normal except for some loss of memory, and his other injuries progressed satisfactorily. Approximately 4 months after his admission to this hospital, he was transferred to an army installation for further treatment.

This is a case in which there was an acute, severe, cerebral injury followed by unconsciousness. This man was unable to clear his tracheobronchial tree by coughing and finally developed an irregular respiration which was probably due to an increasing degree of anoxia. After the tracheotomy was done, his respiratory function responded rather dramatically. In this patient tracheotomy was considered to be a life-saving procedure by those responsible for his care. In retrospect, the tracheotomy probably should have been done earlier before the development of an irregularity of respiratory or cardiac function.

CASE 2. Reg. No. 37 157. This 23 year old white male was in an automobile accident in which he received a massive avulsion injury to the right side of his face and forehead. The wound was ragged and dirty and involved all of the soft tissue including the facial nerve. There were multiple compound, comminuted fractures of the majority of the facial bones on the right. The patient was taken to the operating room where the wound was debrided thoroughly, and a careful closure with an approximation of the injured structures was attempted. Although he tolerated the procedure well, several hours later, while still under the effects of the initial anesthesia, he developed a rapid respiratory rate and an irregular pulse rate. Intratracheal suction was ineffective and difficult to carry out because of the edema and tenderness in the mouth and pharynx. Besides the accumulation of tracheobronchial secretions, a moderate amount of bleeding from the mouth, nose, and nasal sinuses collected in the pharynx and produced a definite aspiration hazard. A tracheotomy was done without further delay and the patient's response was quite rapid. He became alert and rational; his blood pressure, pulse, and respiratory rates stabilized at essentially normal levels. He made a complete recovery except for a facial paralysis on the right. This paralysis was treated with a fascial sling by the plastic surgical staff.

This case presents the difficulty in maintaining an adequate airway in patients with severe injuries about the face and neck. If a tracheotomy had not been done promptly, this patient would have suffered considerable damage from the anoxic state produced by an impaired airway.

CASE 3. Reg. No. 39 331. This 26 year old colored male was admitted 9 hours following a stab wound

of the neck. Physical examination was completely negative except for a small ⅛ inch wound on the left side of the neck and some subcutaneous emphysema in that area. Vital signs were normal and chest x-ray examination was negative. The patient was alert and co-operative. Approximately 5 hours after admission, however, he suddenly coughed up a large amount of blood and his respiration became labored. He became comatose and an emergency tracheotomy was performed aspirating large amounts of blood from the tracheobronchial tree. Cardiac arrest followed immediately. His left chest was opened and cardiac massage carried out accompanied by positive pressure endotracheal oxygen. This attempt at resuscitation was not successful.

This death was in all probability preventable. Had the patient presented any clinical evidence of respiratory embarrassment on admission, tracheotomy would have been done. His clinical picture was deceptive. It is important that any penetrating tracheal wound should be treated promptly with tracheotomy.

CASE 4. Reg. No. 37 945. This 32 year old white male was transferred from the medical service to the thoracic surgical service. The diagnosis was mitral stenosis. After careful workout and preoperative preparation, a mitral commissurotomy was done by the finger fracture method. The patient tolerated the procedure quite well. On the second postoperative day, he began having rapid respiration and a rapid, irregular pulse. It was thought that he was not adequately clearing his tracheobronchial tree and was becoming anoxic. Careful bronchoscopy was performed in the patient's room, and following this, a tracheotomy was done. Thus, the patient was given an adequate airway which was maintained by frequent intratracheal suction through the tracheotomy tube. The remainder of the patient's course was uneventful and his recovery satisfactory.

This case demonstrates the fact that a tracheotomy is of unquestioned value and, in some instances, life-saving after procedures such as this, when it is known that the patient cannot have an effective cough. This procedure should be strongly considered as a prophylactic measure immediately following such a major surgical operation.

CASE 5. Reg. No. 37 149. This 30 year old white male was under treatment for pulmonary tuberculosis. He had had an uneventful right upper lobectomy and approximately 3 weeks later, during a first stage thoracoplasty on the right side, he developed sudden cardiac arrest. The patient was turned, the left chest opened, and cardiac massage begun with a rapid response in cardiac action. Both chest wounds were closed and, before leaving the operating room, a tracheotomy was done as prophylaxis against future difficulty. His postoperative course was marked by some cerebral depression for 10 to 12 hours, and later by intervals of instability in his heart rate and rhythm. During all this time, however, his tracheobronchial tree was kept clean by intratracheal suction through the tracheotomy tube. He has made a satisfactory recovery.

The prophylactic use of the tracheotomy no doubt prevented pulmonary complications due to plugging of the tracheobronchial tree with mucous secretions, and certainly in this patient, such complications might have prevented his survival.

CASE 6. Reg. No. 26 253. This 59 year old white male was admitted to this hospital with signs and symptoms of a perforated peptic ulcer which from his history had been present for approximately 29 hours. The patient was acutely ill. Nonetheless, the surgical staff considered that operative intervention was imperative. Consequently, under local anesthesia a large perforation in an anterior duodenal ulcer was repaired. The patient tolerated the procedure satisfactorily. Prior to surgery it was realized from the physical examination and the chest x-ray film that this patient had massive bilateral emphysematous pulmonary blebs and that, consequently, he would present a serious postoperative pulmonary problem. He had little trouble immediately postoperatively, but about 2 weeks after operation developed massive atelectasis of the lower and middle lobes of the right lung. The patient was seen by the thoracic surgical service who recommended bronchoscopy. The patient's condition became so precarious that it was feared he would not tolerate bronchoscopy. Therefore, at that time, a tracheotomy was done and intratracheal suction begun. This patient's cardiovascular and pulmonary function improved markedly. He continued to show some improvement. Later in his hospital course, he began to have massive gastrointestinal bleeding and 1 month after his admission, expired. Autopsy revealed a second duodenal ulcer posteriorly. This ulcer had eroded into the pancreas and into the gastroduodenal artery.

At the time bronchoscopy was proposed for this patient, any surgical procedure would have been hazardous. The tracheotomy, with intratracheal suction, was certainly responsible for his comeback. In all probability, tracheotomy should have been carried out several days earlier, although it would not have prevented his death from the massive hemorrhage.

DISCUSSION

The cases presented, as well as others, illustrate the value of tracheotomy in some acute-

ly ill surgical patients. In several of the cases reviewed, tracheotomy was obviously delayed too long; whereas, in others it was not performed at all. It is impossible to say how many of these patients would have survived had they received prompt intervention with a tracheotomy. The scope of this paper does not include tracheotomy for carcinoma of the larynx and pharynx, nor does it particularly apply to those tracheotomies which are strictly emergency procedures. In other cases, the following are indications for tracheotomy:

1. In acute cerebral injuries when the patient is comatose or stuporous and cannot clear his tracheobronchial tree by coughing, tracheotomy is indicated. In cases like this the aspiration of food, drink, regurgitated vomitus, or gastric content is a very definite hazard which can be more easily combatted with a tracheotomy tube in place. There are similar indications in cases of brain tumors and of infections of the brain, as well as in other conditions in which the patient presents problems similar to those outlined for cerebral injuries.

2. In severe and massive injuries about the head and neck in which tenderness and edema in the oropharynx are present making intratracheal suction difficult, and in those in which the patient does not have an effective cough, tracheotomy will be of considerable value. The danger of aspiration of pharyngeal and other secretions is also present in this group of patients.

3. All penetrating and severe crushing injuries to the trachea should be treated with tracheotomy.

4. In certain surgical procedures about the head and neck, such as radical neck dissection with glossectomy, or hemiglossectomy, or resection of part or all of the mandible, a tracheotomy should be done as a prophylactic procedure.

5. A postoperative patient in whom the cough is ineffective and the tracheobronchial tree inadequately cleared by intratracheal suction, or by frequent bronchoscopy, should be a candidate for tracheotomy. This is particularly true for those patients who are very ill and in whom bronchoscopy constitutes a real risk. If these conditions can be predicted at the time of surgery, a prophylactic tracheotomy should certainly be done.

6. There will also be some patients with tracheobronchitis or other similar inflammatory conditions in which an inadequate airway will be present due to edema and secretions produced by the inflammatory state. If these individuals fail to respond to medical management and the respiratory difficulties continue, tracheotomy may be necessary.

7. In patients with advanced pulmonary disease who undergo major surgery, and in whom pulmonary complications are strongly anticipated, a tracheotomy may be necessary and certainly should not be delayed after the first evidence of respiratory difficulty.

8. As has been emphasized by Lahey and Prioleau (3, 4), respiratory obstruction is a serious complication of thyroid diseases and in particular of thyroidectomy. Frequently, an emergency tracheotomy is necessary. It is important that the respiratory difficulty be recognized early and promptly relieved. If there is sufficient reason at the time of thyroid surgery to anticipate such postoperative difficulty, a prophylactic tracheotomy is indicated.

In general, the indications for tracheotomy include those cases in which there is some respiratory obstruction, or those in which there will be difficulty in maintaining a clear tracheobronchial tree due to an ineffective cough. This may be impossible either from the standpoint of the patient's illness or the nature of his operative procedure or injury. When the patient has an inadequate airway, or has inadequate pulmonary function due to obstruction of some part of the tracheobronchial tree, anoxia develops with its resultant effects on the cardiovascular, cerebral and respiratory mechanisms of the body. If this cannot be eliminated by effective coughing, by nasal intratracheal suction, or by bronchoscopy, the patient, with rare exceptions, needs a tracheotomy. We urge prompt use of this relatively simple method in such cases before irreparable damage or death results.

CONCLUSIONS

1. The value of tracheotomy as an adjunct to treatment of certain severely ill patients has been stressed.

2. Several cases illustrating the importance of tracheotomy in various types of patients have been presented.

3. Indications for tracheotomy have been listed.

4. A plea is made for more prompt use of tracheotomy in such patients.

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RECURRENT HERNIAS

An Analysis of 369 Consecutive Cases of Recurrent Inguinal and Femoral Hernias

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THE fact that recurrences following hernial repairs still occur with all too great frequency was the stimulus for this study of 369 consecutive recurrent hernia operations performed by Dr. E. E. Shouldice (326 cases) and Dr. N. Obney (43 cases) at Shouldice Surgery during a 9½ year period (August 1941 to March 1951). Only 12 repairs were carried out in the first 4 years of this period. All types of hernias recurring in the inguinal or femoral regions were considered as recurrences, as they were by the patient himself. The technique used was that developed by E. E. Shouldice (8) with gradual but considerable improvements by himself and co-workers during the years (9). Almost all the operations were done under local anesthesia, and immediate early ambulation was carried out. Advanced age in itself was not looked upon as a contraindication to operation. In 291 cases stainless steel wire sutures were used for the repair, in 77 cases silk sutures, and in 1 case fascia. No restrictions whatsoever were placed on the patients' activities after their discharge from hospital on the third postoperative day.

OBSERVATIONS

General. Of the 369 operations, 357 were in males and 12 in females. In 238 cases (64.5 per cent) the right side was involved and in 131 cases (35.5 per cent) the left side. Bilateral recurrent hernias were repaired during one admission to the hospital (usually with an interval of 2 days) in 19 cases. Bilateral recurrent hernias were repaired on separate admissions in 6 cases. In 1 individual there was a recurrence of a recurrent hernia repaired at the Shouldice Surgery. Thus the total number of individuals operated upon was 343 with 26 of these having 2 operations. In 53 cases an original nonrecurrent hernia was repaired on the opposite side during the same admission with a period of 2 days between operations. Thus there were 72 individuals (21 per cent) with bilateral hernia repairs during the one admission. Of the 369 cases there were 308 that were once recurrent, 54 twice, 6 three times, and 1 four times recurrent.

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Types of recurrences. Of the recurrences 194 (52.6 per cent) were indirect, 167 (45.2 per cent) were direct, and 8 (2.2 per cent) were femoral hernias. Of the indirect hernias 16 (4.4 per cent of total, 8.2 per cent of indirect) were sliding in type. If the 12 females and the 1 male under 21 years of age who were operated on for recurrences are omitted, the distribution for adult males was indirect hernias 187, direct 164, and femoral 5. If only the men 61 years old and over at the time of our operation are considered (100 cases), there were 53 indirect, 45 direct, and 2 femoral hernias. Thus in this group the ratio of indirect to direct hernias was 1.18 to 1 which is a small increase in the percentage of indirect hernias in this older age group, and perhaps contrary to expectation. In this older age group, 87 hernias were once recurrent, 12 twice recurrent, and 1 three times recurrent.

Recurrences in relationship to previous type of repair. At operation the type of previous repair was judged to have been a Bassini in 287 cases, a Halsted in 70 cases, a modified Halsted in 5 cases, a Ferguson type in 5 cases, and a femoral type in 2 cases. The previous repair was judged to have been of a Bassini type if the cord was found deep to the external and superficial to the internal obliques. If the cord was also deep to the internal oblique muscle, it was considered to have been a Ferguson type of repair. If the cord was super-

ficial to the external oblique, the previous repair was considered to have been of the Halsted type. When the types of recurrences after the different types of previous repairs were considered, it was found that after the 287 Bassini operations there were 148 indirect (51.5 per cent), 134 direct (46.7 per cent), and 5 femoral hernia recurrences. Of these recurrences there were 25 cases in which 2 types of recurrent hernias were found on the one side. After the 70 Halsted operations, there were 42 indirect (60 per cent), 27 direct (38 per cent), and 1 femoral hernia. In 18 cases in this group, 2 hernias were found at operation. After the 5 Ferguson operations, there were 1 indirect (20 per cent) and 4 direct (80 per cent) hernia recurrences and no double hernia recurrences. Of the 13 hernias recurring after having been repaired initially at Shouldice Surgery (recurrence rate of less than 1 per cent in 5,500 cases performed over 1 year before), there were 2 indirect (1 sliding), 15.4 per cent, and 11 direct, 84.6 per cent. After the 2 femoral hernia repairs the 2 recurrences were of the femoral type.

If for all types of repairs we summarize the 43 cases (11.7 per cent) in which 2 hernias were found at operation, we find that considering the major recurrence first there were 18 indirect plus direct hernias, 18 direct plus indirect, 5 direct plus small femoral, and 2 direct plus a second direct hernia. We might also note here that there were 4 direct hernias with large fat tabs at the internal ring, and in 1 indirect there was a similar large fat tab. On occasion such large fat tabs produce symptoms and simulate hernias. In these cases of double hernias on the one side the more minor hernia was usually of a small size, but it was still large enough that the operator judged that if it had been alone it would have been evident, or would ultimately have become evident, as a recurrence. It is these second hernias which are apparently frequently overlooked by surgeons inexperienced in this field.

On further analysis of the unsuccessful Halsted operations, it was found that for the first postoperative year the ratio of indirect to direct hernias was 2 to 1, and for the first 5 postoperative years was 2.4 to 1; while for all once recurrent hernias this ratio was 1.4 to 1 for the first postoperative year and 1.25 to 1 for the first 5 years. Recurrences taking place more than 5 years after a Halsted repair were equally distributed between direct and indirect hernias as they were for all types of hernial repairs. It is thus evident that the increased incidence of indirect hernia recurrences following Halsted repairs as compared to Bassini repairs takes place in the first 5 years following operation. The percentage of the total hernia recurrences occurring in each postoperative year after Halsted repairs was, however, essentially the same as for the whole group. It is also evident that the Halsted type of repair does not produce an immunity from direct hernia recurrences. There was, on the other hand, no evidence that the Halsted type of repair predisposed to weakness in the femoral or interligamentous regions which might possibly have been considered the case.

Sutures used in previous repairs. While it was not always possible to be certain as to the suture material used previously, in 317 cases there was no evidence of any suturing material, and it was assumed that in these cases the previous repair had been with catgut. In 15 cases silk sutures were found. In 11 cases wire had been used in the previous repair and in 26 cases fascia. Of the fascial repairs 8 had been of the McArthur type. It is interesting to note, in those cases known to have been repaired previously with fascia, that in some cases the fascial bands were well preserved while in others they had disappeared in part or completely.

Age at time of operation. At the time of our operation the average age in the 369 cases was 52.13 years, with a range of from 3 to 87 years and a peak incidence between the ages of 51 to 60 years (43 cases). There was only 1 patient under 20, and there were 21 patients over 71 years of age. If only the adult males over 21 are considered the average was 52.4 years (356 cases). If only the females are considered the average age was 48.1 years (12 cases), and the peak incidence was between 41 to 50 years (6 cases).

Age at time of previous repairs (as reported by patients). The average age at the time of the first of the previous repairs was 38.5 years (341 cases known), with the peak incidence

between 31 and 40 years (80 cases). The initial repairs in 38 cases had been performed prior to the age of 21 years, and of this group 12 patients had been under 11 years of age. In 3 cases the initial repairs had been carried out in patients over 70 years of age. The average age at the time of all previous repairs, including each repair if more than one was carried out on any one individual, was 39.11 years for the 395 known cases (unknown 43).

Duration of previous repairs (as reported by patients). The average duration of all previous repairs, including each repair if multiple repairs had been carried out, was 70.44 months (5 years 10 months) for 388 cases (50 unknown). The maximum incidence of recurrences was between 1 to 6 months after the repair (78 cases). During the first year there were 196 cases, while in the next highest year, the second year, there were only 34 cases; thus in the first year 5.7 times as many recurrences took place as in any other year. Thus 50 per cent of all recurrences occurred within the first postoperative year.

If only the first of the previous repairs is considered the average duration of the known cases was 77.2 months (6 years 5½ months) (332 known cases, 37 unknown cases). The maximum incidence of recurrences was again between 1 to 6 months. The number of cases recurring per year becomes less as the time from the repairs increases. The rate of recurrences per year in 332 cases was: first year, 158 cases; 2 to 5 years, 16.5 cases; 5 to 10 years, 6.2 cases; 10 to 15 years, 5.8 cases; 15 to 20 years, 2.8 cases; 20 to 40 years, 1.7 cases per year. Thus apparently the longer a hernial repair has remained intact the less the likelihood of its recurring eventually. If those with first repairs as children under 10 are omitted, then of 320 cases the average duration of the repairs was 60.85 months.

If the several times recurrent hernias are considered the average duration in those cases repaired twice was 33.16 months (2 years, 9 months) for 50 known cases (11 uncertain). For those hernias repaired three times previously the average duration of the repairs was 5.4 months for 5 cases (2 cases uncertain). In the 1 case repaired four times previously the repair lasted only 1 month.

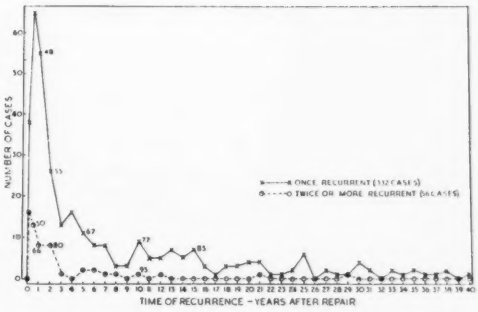

Fig. 1. The duration of unsuccessful hernial repairs. The figures by the different points indicate the percentage of the recurrences that have taken place in the time indicated by the point in question. Note that: (a) the great preponderance of recurrences were within the first postoperative year (48 per cent in once recurrent hernias and 66 per cent in twice or oftener recurrent hernias); (b) 15 per cent of the recurrences of original hernias take place more than 15 years postoperatively; (c) a 10 year follow-up is needed to bring to light 75 per cent of the recurrences; (d) the recurrences in unsuccessfully repaired recurrent hernias become evident earlier than the recurrences in the initial hernial repairs.

From Figure 1, it is evident that by far the maximum incidence of recurrences in initial hernial repairs is in the first 6 months after operation (31 per cent of cases) and that 55 per cent of recurrences have occurred within 2 years postoperatively. Sixty-six per cent of the recurrences in repaired recurrent hernias had taken place within 1 year and 80 per cent within 2 years. The maximum incidence of recurrence in this group was within the first postoperative month (Fig. 1). The average time interval between the patient's recognition of the recurrence and our operation was 73.3 months (6 years, 1 month).

Relationship of type of hernia to duration of repair. A comparison of the number of direct and indirect hernial recurrences after the initial repairs (Fig. 2) indicates that indirect hernias predominate in the first year but thereafter the incidence of each is approximately equal. In hernias recurring more than 10 years after operation, the numbers of direct and indirect hernias were about equal. Recurrences of each type occurred both early and late after both Halsted and Bassini repairs.

Anatomic basis of hernial recurrences (Table I). Considering the direct hernial recurrences no clear cut anatomic factors can be adduced

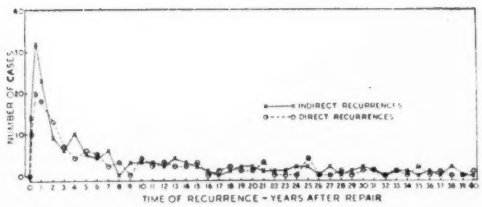

Fig. 2. Types of recurrences associated with the duration of unsuccessful hernial repairs (284 once recurrent hernias). Note that: (a) the preponderance of recurrences of the indirect hernias over the direct was in the first postoperative year, and, in the subsequent years, the incidence of direct and indirect hernial recurrences is approximately the same; (b) indirect hernias are as common as direct hernias in those recurrences taking place more than 10 years postoperatively. (This finding surprised us.)

except that there is weakness in the posterior wall of the canal, particularly in the region close to the pubic bone. Of the 167 direct hernial recurrences, 80 came out just lateral to the pubic tubercle, 47 came through the conjointed tendon, 13 through the middle of the posterior wall of the inguinal canal, and 4 just medial to the deep epigastric vessels. In the remaining cases the exact site was not noted. Thus the more lateral in the posterior wall of the inguinal canal the less the likelihood of a direct hernia coming through. In 1 case the recurrence was related to the path of the cremasteric vessels through the posterior wall. In 15 cases (9 per cent of total direct) of the 47 in which the hernia was judged to come through the conjoined tendon, the protrusion was found to be just immediately lateral to and in contact with the edge of the rectus. This is a site of recurrence which, in our opinion, has not previously been adequately stressed (Fig. 3). The fact that in 9 per cent of the cases the hernia came out just lateral to the edge of the rectus muscle indicates the importance of careful checking in this region during hernia repairs. In some cases quite a groove can be felt between the edge of the rectus and the overlying conjoined tendon. It was thought that this might be a factor in funneling the pressure into this region thus acting to predispose to direct hernia. In the direct hernias recurring in less than 1 year it is certain that some of these were missed hernias, i.e. hernias or potential hernias overlooked at operation while an indirect sac may have been removed (Table I, Fig. 3). In other cases the early recurrence was likely due to a grossly inadequate type of repair. Late direct hernial recurrences are common and are apparently due to inadequate repair of the layers in the region of the pubic tubercle, particularly of the transversalis layer.

When the indirect once recurrent hernias (Table I) were considered and, first, those cases occurring more than 1 year postoperatively (84 cases), the major etiologic factors seemed to be two in number, namely either laxity at the internal ring (35 cases) or inadequate initial removal of the hernia sac (48 cases). In some cases both factors seemed to be contributory. The relative incidence of each of these factors remained approximately the same throughout the whole period of from 1 to 40 years postoperatively. In 1 case it was felt that the cause was weakness in the internal oblique muscle lateral to the internal ring. The major contributing factor in those recurrences due to inadequate removal of the sac was judged to be failure to free the neck of the sac from the transversalis fascia throughout its entire circumference so that it would be unattached to and entirely deep to the latter structure following the repair. Possibly the more completely the neck of the sac was freed from the transversalis layer the longer the repair lasted. The postulated causes for indirect hernial recurrences under 1 year postoperatively (70 cases) were: inadequate removal of sac (40 cases); lax internal ring (18 cases); failure to find and remove the sac (11 cases); missed hernia (1 case).

There were 16 indirect sliding hernia recurrences all of which recurred after Bassini type operations; 14 were in once recurrent hernias and 2 in twice recurrent hernias. Average duration of the immediately preceding repair was 6 years and 6 months which was the same as for all once recurrent hernias. Average age was 58.3 years which was older than the overall average. In 9 cases a lax internal ring was the cause, and in 7, inadequate removal of the sac. In all other indirect hernias inadequate removal of the sac was oftener the cause than the lax internal ring. Thus it appears that a lax internal ring tends to predispose to the sliding type hernia.

Of the 6 femoral hernias recurring after initial repairs, 5 recurred within approximately 1 month. They had apparently been missed completely at the time of the first operation or possibly, although less likely, a grossly inadequate repair had been carried out. The sixth case recurred within less than 1 year, and it is possible that at the time of the original operation an inguinal hernia was repaired while a very small femoral hernia was missed which then gradually increased in size over this period of time and became evident. Two of these cases were in females. One male had recurrent femoral hernias on each side. There was 1 twice recurrent and 1 thrice recurrent hernia of the femoral type.

Apparently the commonest reason for the recurrence of femoral hernias was complete oversight of the femoral hernia at the initial operation (Fig. 4).

Various bodily measurements in those having recurrent hernias. The average values were: weight 161.35 pounds (313 known cases); height 5 feet 7.3 inches (308 known cases); waist measurement 35.32 inches (160 known cases). If children and females are omitted from the calculations so that only males over 21 at the time of our operation are considered then the average values are: age 52.4 years (356 known cases); weight 162.4 pounds (300 known cases); height 5 feet 7½ inches (296 cases), waist 35.4 inches (154 known cases). If only the females dealt with are considered then the average values for 12 cases are: age 48.1 years, height 5 feet 4½ inches, weight 143.7 pounds; and, for the 6 known cases, waist 32 inches.

By considering that group whose recurrences took place more than 5 years following initial operation it was believed that contributory physical characteristics might become evident which were masked in the whole group because of the large number of early recurring hernias due solely to inadequate surgery. When this was done and only the once recurrent hernias were considered the following average values (100 males) were obtained: age 52.85 years; weight 163 pounds; height 5 feet 7¾ inches; waist measurement 35.5 inches. Fifty-one per cent did light work, 33 per cent moderate work, and 16 per cent heavy work.

TABLE I.—RELATIVE IMPORTANCE OF VARIOUS ETIOLOGIC FACTORS PRODUCING HERNIAL RECURRENCES BASED ON FINDINGS IN 284 ONCE RECURRENT HERNIAS

	No. of cases	Per cent
Hernia recurring as indirect hernias (154 cases)		
Inadequate removal of the sac (failure to free the neck of the sac completely from the transversalis fascia and to place the stump of the sac entirely deep to it in the repair)	86	55.9
Laxity of internal ring (failure to close the transversalis fascia snug about the cord after the removal of the sac)	53	34.4
Missed hernias		
Complete failure of operator to find sac	11	7.1
Another hernia repaired and one at internal ring overlooked	3	1.9
Unrecognized weakness lateral to the internal ring	1	0.7
Hernia recurring as direct hernias (124 cases)		
Inadequate repairs leaving posterior wall of inguinal canal still weak	93	75
Missed hernias		
One hernia apparently repaired but another 1 overlooked	19	15
Failure of inexperienced operators to find sac	12	10
Femoral hernias (6 cases)		
Missed hernias	4	66.6
Inadequate repairs of hernia	2	33.3

These values very closely approximate those for the whole group with no striking differences, and the measurements would seem to be essentially average for a 52 year old group although exactly comparable statistics for Canadian men could not be found. These facts suggest that there is no outstanding physical quality among those considered which predisposes to hernial recurrences.

Relationship of occupation to recurrences. In each case, the individual's work was classified under the heading of light, moderate, or heavy. There were thus found to be 177 (48.7 per cent) doing light work, 136 (37.5 per cent) moderate work, and 50 (13.8 per cent) heavy work, with 6 cases in which the occupation was unknown. In 4 cases there was a history of the sudden recurrence of the hernia while heavy work was being done, but on the whole heavy work did not seem to be a major factor in the recurrences.

An attempt was made to classify these patients into occupational groups. Salesmen made up the largest group of individuals, numbering 27; of the other occupations there were 18 farmers, 14 laborers, 9 barbers, 6

druggists, 5 butchers. It was thought that long standing might be a factor in hernia recurrences, and on analysis it was judged that in 84 (23.1 per cent) cases the individuals' work did involve long standing.

Influence of infection on recurrences. A consideration of recurrences in hernias repaired at this hospital had suggested that infection was a definite predisposing cause for recurrences. In this series however, there were only 6 patients with a definite history of previous infection, and considerable scarring at operation suggested that it had been a factor in 2 other cases. This is a total of 8 or only 2.2 per cent of the cases studied.

Recurrence of hernias repaired in childhood. In 12 cases the initial repair had been carried out in childhood (average age 3.4 years, range 1 to 7 years). The average duration of the initial repairs was 20.7 years, which is much longer than the average for the whole group (3 times longer). One repair in a child aged 1 year lasted for only 1 month and a second repair was then carried out which lasted for 1 year. The third repair was then carried out at this hospital and has been successful to date. In the other 11 cases 10 were once recurrent hernias at the time of our operation and the shortest duration of repair was 4 years. One case was twice recurrent prior to our operation. Of the 10 children operated on in childhood who had their second operation at this hospital and thus the type of recurrence was known, 9 cases recurred as indirect hernias and 1 as a direct hernia (after 37 years). It would, therefore, seem that in the 9 cases of indirect hernia there had been inadequate treatment of the initial indirect sac which must almost certainly have been present at the time of the first operation.

Recurrent hernia in females. There were 12 recurrent hernias in females, 6 being indirect, 3 direct, and 3 femoral. Nine of these were recurrent for the first time, 1 for the second, and 2 for the third time. The average duration of the initial repairs was 1 year and 6 months (11 known cases) (range 1 month to 5 years). If the femoral hernias are considered separately the average duration for the inguinal hernias was 1 year and 11 months (8 cases), and the average duration of the initial repairs of femoral hernias was 5 months (3 cases). Thus the duration of the unsuccessful repairs in the females was on the average much shorter than was the case in the males. On anatomic considerations one would expect that a permanent repair might more easily be obtained in females than in males. Of the 3 femoral hernias in this group each had recurred within 6 weeks of the operation immediately preceding, suggesting that they had probably been either completely overlooked at the time of that repair or else very inadequately repaired. Two of these had been repaired only once previously, while 1 had been repaired three times. If the recurrences as inguinal hernias only are considered, 33 per cent were direct hernias. In 97 initial female inguinal hernial repairs, 12.8 per cent were direct hernias. Thus in females there is a greater incidence of direct hernia among recurrences than in initial hernias.

Recurrence in recurrent hernia repairs. In 50 unsuccessful repairs of recurrent hernias, the duration of the immediately preceding repair and the type of recurrence were known. In this group there were 45 twice recurrent hernias, 4 thrice recurrent hernias, and 1 four times recurrent hernia. Twenty-six of the recurrences were direct hernias (23 of them twice recurrent), 22 indirect (21 twice recurrent), and 2 were femoral (1 twice recurrent). Thus in this group the direct hernias predominated in contrast to the once recurrent hernias in which the indirect type were in the majority. Also in this group there was no preponderance of recurrences of indirect hernias in the first postoperative year as there was among the initial recurrences (Fig. 2); if anything, the reverse was the case. The fact that 50 per cent of the recurrent hernias in unsuccessful repairs recurred within 6 months (Fig. 1) suggests that the actual hernias in these cases were overlooked or that the repair was grossly inadequate. The reasons for the failures of recurrent hernial repairs seem to be the same as those for the failures of initial hernial repairs.

Recurrences in hernias previously repaired at Shouldice Surgery. It was felt that a study of the recurrences in cases previously done at Shouldice Surgery would be most likely to give guidance as to possible improvements in

technique. There were 13 such cases in this study in which the average age of the patient was 51.9 years. The original operation had been done in the following years: 1 in 1943, 5 in 1944, 1 in 1945, 3 in 1946, 1 in 1947, 2 in 1948. Twelve of the operations had been done by Dr. Shouldice and 1 by Dr. Obney. The average duration of the repairs was 2 years and 3 months, with only 2 cases recurring in less than 1 year. Of the original hernias, 11 were indirect of which 2 were sliding, and 2 were direct. The type of recurrences were 2 indirect (1 sliding) and 11 direct hernias, i.e. 85 per cent direct. In 8 cases the right side was involved and in 5 the left. In 3 cases both sides had been done on 1 admission previously. As to the etiology of the recurrences the following points were noted. In each of the 11 recurrences as direct hernias the repair in the region of the internal ring was good. In the recurrence as an indirect sliding hernia the original hernia had been sliding, and the cause for the recurrence was thought to be weakness in the internal oblique just lateral to the internal ring. Care is now taken to check this region in each case and to cut laterally and repair as far laterally as is necessary until a good layer of internal oblique is reached. There have been no recurrences as indirect hernias as of April 1, 1952 in any of the 7,000 cases done at this hospital since July 1944, i.e. in a period of 7 years. The direct hernias recurred either just lateral to the edge of the rectus (Fig. 3) or just above the pubic bone and it was surmised that direct or incipient direct hernias had been missed at the primary operation. As a result of these findings, since January 1948 care has been taken in each case to investigate the posterior wall of the inguinal canal thoroughly just lateral to the edge of the rectus and to repair any weakness that might be present there. Also efforts for improvement in technique should be concentrated in the area of recurrences as direct hernias.

Postoperative complications following repairs of the recurrent hernias studied. There was no mortality in this series of 369 cases. Atrophy of the testicle occurred in 15 cases. In 17 cases the testicle was removed at the time of operation. In 11 cases hydroceles were removed with preservation of the testicle, and in 2 cases the tunica vaginalis was opened. There were 7 cases of postoperative hydroceles. In 2 of these cases a previous hydrocele had been removed. There were 11 postoperative infections (3 per cent). Three appendectomies were carried out at the time of operation because the appendix was involved in the hernial sac. In 3 cases the vas, obscured by scar, was cut or injured during the operation. One patient required a prostatectomy in the early postoperative period. There were only 2 individuals with recurrences but in 1 of these the hernia recurred twice, a total of 3 recurrences. Thus there were 2 recurrences in once recurrent hernial repairs and 1 recurrence in a twice recurrent hernial repair. This is a recurrence rate of 0.81 per cent. These recurrences were all on the left side. The earliest recurrence was within 1 year and 6 months, with an average time of 2 years and 4 months. One of these recurrences was as an indirect, another as a direct hernia. The second recurrence in the 1 man has not yet been repaired but is thought to be a direct hernia. The recurrence as an indirect hernia was in an early case (March 1944) and was thought to be due to some laxity at the internal ring. The man with the recurrence as a direct hernia was one who had had recurrent hernias on both sides repaired during one admission. The recurrence was on the side operated on second and was at the lateral edge of the rectus. It was thought that this recurrence was due to inadequate strengthening of this region at the time of the initial operation prior to the time that this area was routinely checked. This patient also developed postoperative urinary retention following the original operation which probably put excessive strain on the repair in the immediate postoperative period.

Follow-up study of repairs of recurrent hernias. An intensive follow-up procedure has been routine at this hospital, particularly since 1948. This study includes the sending of a follow-up letter to each patient on each anniversary of his operation requesting him to report to us for examination free of charge, or if he lives farther than 100 miles from Toronto, to his family physician, the Shouldice Surgery paying a 3 dollar examination fee

TABLE II.—FOLLOW-UP TO FEBRUARY 1, 1952 ON RECURRENT HERNIAL REPAIRS CARRIED OUT AT SHOULDICE SURGERY UP TO MARCH 3, 1951

Minimum duration of follow-up	Method of latest follow-up with numbers of cases			Number followed with per cent of possible follow-up				No. of recurrences in time of follow-up	Per cent recurrences	
	Surgery doctors	Other doctors	Letter or phone	Followed No.	Followed Per cent	Checked by doctors No.	Checked by doctors Per cent		Of all cases followed	Of cases seen by doctors
6 mos.	246	16	57	319	86.5	262	71.0	0	0	0
1 yr.	210	16	56	282	82.2	226	65.9	0	0	0
2 yr.	139	11	11	191	73.5	150	57.7	2	1	1.3
4 yr.	39	3	23	65	58.5	42	37.8	2	3.1	4.7

on receiving the doctor's report. One factor, which it is believed practically assures that all patients with recurrences of hernias repaired at this hospital will return to us rather than go elsewhere, is the fact that it has been the practice to repair any such recurrences free of any charge to the patient either for hospitalization or professional care.

The follow-up report on the recurrent hernia repairs is as of February 1, 1952. At that time 10 of those operated upon had died of causes unrelated to their operations, all with their hernia repairs sound at the time of death. None of these individuals died in less than 6 months from the time of their operations, and the average survival time was 2 years and 11 months. Follow-up details are given in Table II. There were only 3 known recurrences, an incidence of 0.8 per cent. There has been only 1 recurrence in the group repaired since November 1945 (i.e. 339 cases, incidence 0.29 per cent), and this was in 1948. There have been no recurrences in the 190 cases done from 1948 up to March 1951. The recurrence rate in the 150 patients examined by doctors (10) 2 years or more postoperatively was 1.3 per cent.

DISCUSSION

In our series the recurrences on the right side predominated over the left by an almost 2 to 1 ratio. This figure agrees with the finding of Patrick in a study of 70 cases and may be associated with the much greater incidence of right handedness than left handedness so that greater and more frequent strains may be experienced on the right side than on the left. An analysis of 4,837 cases of inguinal and femoral hernias at the Shouldice Surgery (1) gave a ratio of right side to left side of 1.4 to 1. In the recurrences studied in this report the ratio was 1.8 to 1. This fact suggests that there is a greater preponderance of right-sided hernias in recurrent than in original hernias.

Of the suture materials used in the previous repairs including catgut, silk, wire, and fascia, none in itself guaranteed a successful repair. The adequacy of the technique is the important factor, and the type of suture material used is of very secondary consideration. It is likely, however, that a nonabsorbable suture is better than catgut because of variability in the time of disintegration of the latter, particularly if infection ensues. Silk, while nonabsorbable, has the disadvantage that, if infection occurs, sinuses are formed which do not close unless the offending piece of silk is secondarily removed. Since wire has neither of these disadvantages and since it produces minimal tissue reaction, it was adopted as the routine suture material for hernial repairs at Shouldice Surgery.

Of the recurrences, the indirect type of hernia predominated except in those recurrences taking place after the repair of already recurrent hernias, in which group the direct hernias predominated. We were rather surprised that the number of direct hernias did not increase with age but that rather the reverse was the case. It has also been found that in those patients receiving their initial hernia operations at this hospital (1) the incidence of indirect to direct hernias remains approximately the same in those over 61 years old as for the whole group. The ratio of indirect to direct hernias was 2.8 to 1 for those patients over 61 and 3.0 to 1 for the whole

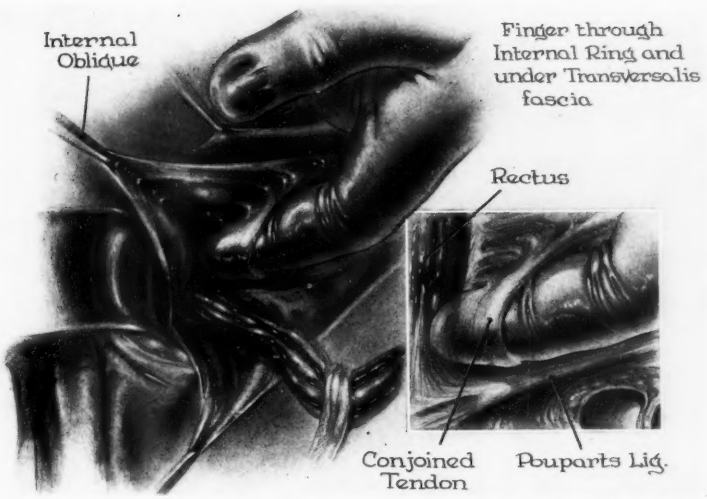

Fig. 3. The site of weakness in the conjoined tendon just lateral to the edge of the rectus. If an indirect hernia is repaired and this weakness is unrecognized and not repaired, it will, if not clinically recognizable at the time, usually eventually give rise to a definite clinical hernia. This has been found to be a fairly common cause of so-called recurrences and is one type of missed hernia. In the drawing it is to be noted that the part labelled "conjoined tendon" is actually only the somewhat thickened lateral edge of the conjoined tendon.

group of 5,000 cases. The fact that the indirect to the direct hernia ratio is lower (1.18 to 2.9) in the recurrent than in the initial series indicates a considerably greater relative incidence of direct hernias among the recurrent than among the initial hernias (approximately 2.5 times more direct hernias among recurrent than in original hernias). This holds true for women as well as for men.

The maximum incidence of recurrences was in the first 6 months following operation in which period 36.6 per cent of all the recurrences studied took place. In his series Fallis found that 41 per cent occurred within this period. There have been no recurrences in less than 6 months postoperatively in over 7,000 initial hernia repairs carried out at Shouldice Surgery. This fact indicates that by good surgery this 36.6 per cent of recurrences can be completely obliterated and that they are essentially due to inept initial repairs. Fifty per cent of all recurrences had taken place within 1 year postoperatively. Those between 6 months and 1 year postoperatively we believe also to be preventable.

The fact that the more frequently a hernia had been recurrent the sooner it recurred again after an inadequate repair suggests the inadvisability of those surgeons inexperienced in the field to deal with recurrent hernias.

An interesting observation was that, in the recurrences of hernias repaired over 10 years before, indirect and direct hernias occurred in approximately equal numbers. It had been believed that the direct hernias might predominate after this time, but the facts belied this viewpoint. It is somewhat difficult to understand why an indirect hernia should recur after this length of time. It would be thought that an inadequate indirect hernial repair would become manifest more quickly, but this is evidently not the case. As Patrick has noted, in many cases, in view of the inadequacies of the initial repair, it was more difficult to explain why the repair had lasted as long as it did than why a recurrence had eventually ensued.

The fact that only 13.8 per cent of the individuals developing recurrent hernias were doing heavy work, while 48.7 per cent were

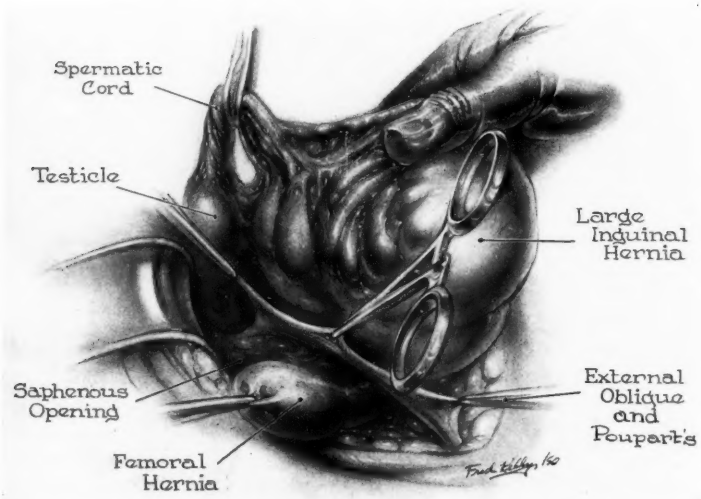

Fig. 4. Illustration of the not uncommon finding of a double hernia on the one side. In this case there are indirect and femoral hernias. It is not unusual in these circumstances for the femoral hernia to be overlooked and not repaired so that an early so-called recurrence results. This would be an example of a missed hernia.

doing light work, suggests that heavy work has relatively little to do with hernial recurrences, and that much more depends on the method used in the repair.

As to the reasons for recurrence other than complete failure of the inexpert to find the sac, especially in the first 6 month period we have to consider hernias which were missed at the time of operation; others have called these "false recurrences." Femoral hernias are not infrequently missed even by well qualified surgeons. Occasionally an indirect hernia is removed and a direct one missed or the reverse. It is, therefore, patently necessary in every case to check these three main possible hernial sites. Even in this series of 369 recurrent hernias, 2 hernias were found on the same side in 43 cases. If the second hernias in these cases had been overlooked the operation would have been judged a failure giving a recurrence rate of 11.7 per cent from this cause alone. In examining for the possibility of a direct hernia, particular attention must be given to the area in the conjoined tendon just lateral to the edge of the rectus muscle where weakness is not uncommon (9 per cent) and may easily be overlooked. If the lower edge of the conjoined tendon only is used in the repair, it is obvious that the weakness in this area will be accentuated thus predisposing to recurrences. Koontz and Patey have noted recently that this area may at times be weakened when the anterior sheath of the rectus is split for relaxation purposes, and we also have found this to be the case. The fact that, of the 12 recurrences in women, 3 were as direct hernias indicates that this type of hernia does occur in women and that this region must be checked and, if necessary, reinforced in women as well as in men. The fact that all recurrences in females took place within a period of less than 5 years postoperatively suggests that inadequate surgery is the main factor leading to recurrences in women.

The finding that a relatively small percentage of the group studied (12 cases, 3.2 per cent) had had repairs as children and that the average duration of the repairs was much longer than in adults would seem to bear out the generally accepted viewpoint that hernia repairs in children are more permanent than in adults. However, the fact that recurrences of hernias repaired in childhood do occur indicates that such hernias are not immune to

recurrence, as some people have implied, and stresses the need for care in the operative procedure initially carried out. The great preponderance of recurrences of indirect hernias suggests that in children there is little likelihood of the presence of a significant weakness in the direct hernial area and that the main efforts should be directed to an adequate repair of the indirect hernia.

It is interesting to note that except for definite femoral hernias there were no recurrences below Poupart's ligament. This is evidence against McVay and Anson's viewpoint that Cooper's ligament rather than Poupart's ligament should be used as the point of fixation below. Burton found that the majority of "interligamentous" hernias were of a femoral type. If the femoral and interligamentous regions are investigated at every operation, as is routinely done at this hospital, and any indicated repairs are carried out, it would seem that the possibilities of a further hernia below Poupart's ligament would be negligible. Thus this possibility should not be looked upon as a contraindication to the use of Poupart's ligament in hernial repairs. Others also have believed that McVay's condemnation of the use of Poupart's ligament in hernial repairs was unjustified.

In every case these patients were ambulatory at once, being up and around the day of the operation as soon as the effects of the sedatives had worn off. The very low recurrence rate obtained in these notoriously hard to cure hernias indicates that there are no deleterious effects in this regard from early ambulation. It is possible that early ambulation might show up the results of bad surgery earlier. There were no cases of phlebitis or pulmonary emboli in this series and indeed after none of the hernia operations carried out at this hospital.

Despite the fact that this series is larger than any of which we are aware the recurrence rate in the repaired hernias (1.3 per cent in those rechecked by a doctor more than 2 years postoperatively) is less than any reported in the literature. In their review of the literature on the subject Stein and Casten concluded that the recurrence rate in recurrent hernial repairs varied from 25 to 35 per cent. The fact that in this series there were no recurrences in the first postoperative year is in striking contrast to our finding that 80 per cent of the recurrences of recurrent hernias occurred within the first postoperative year (Fig. 1) and suggests that with good surgery these early recurrences are almost completely preventable. Our results indicate that recurrent hernias can be repaired as successfully as initial hernias.

The findings that 32.6 per cent of the recurrences took place more than 5 years after operation and that they recurred as late as 40 years following the initial repair indicated that 5 year follow-up studies certainly do not give the whole picture of hernial recurrences. Just 55 per cent of the recurrences after initial hernia repairs had taken place within 2 years of the operation so that 2 year follow-up examinations give still less of the true picture. By 10 years postoperatively 77 per cent of recurrences had occurred, and the recurrence rate had fallen to a low yearly level. Thus for an excellent follow-up study of hernia operations, it would appear that 10 years should be the minimum desirable time.

CONCLUSIONS

1. At least 36.6 per cent of the 369 recurrences reported in this paper have been proved to be due to inadequate surgery and preventable, as they recurred within less than 6 months following operations; while in over 7,000 hernia repairs carried out at Shouldice Surgery there have been no recurrences within 6 months or less postoperatively.

2. Missed hernias form the basis for some recurrences, i.e., a hernia is repaired in one area but a small hernia or potential hernia in another area is overlooked. Femoral hernias may be overlooked even by good surgeons.

3. The lateral edge of the rectus is a common site for direct hernias to occur (9 per cent of direct recurrences); therefore, this area should be checked at each operation and repaired if weak.

4. Recurrences as indirect hernias predominate in the first postoperative year, particularly after Halsted repairs.

5. The major cause of recurrences as indirect hernias was judged to be failure com-

pletely to free the neck of the hernial sac from the transversalis fascia with subsequent replacement of the stump of the sac deep to it in the repair.

6. As 86 per cent of these recurrences were in individuals doing light or moderate work, it is evident that heavy work is not a major factor in producing hernial recurrences.

7. The physical characteristics of height, weight, and waist measurement have little, if any, relationship to hernial recurrences.

8. Hernias repaired in childhood are not immune to recurrence. These recurrences are usually indirect in type (9 in 10 cases).

9. Recurrences of inguinal hernias in females do occur and are occasionally of the direct type.

10. Recurrences more than 10 years postoperatively (10 to 40 years) were approximately equally distributed between direct and indirect hernias.

11. Untrained individuals particularly should avoid dealing with recurrent hernias, as inadequate repairs tend to break down early.

12. The relative incidence of direct hernias is much greater (2.5 times) in once recurrent than in original hernias and is still greater among hernias more than once recurrent in which group the direct hernias actually outnumber the indirect ones. These findings indicate that the greatest site of weakness in hernial repairs is in the direct hernia region.

13. Sliding hernial recurrences (indirect) are most commonly associated with a lax internal ring and occur in an older than average age group (average 58 years). Any weakness lateral to the internal ring should be repaired if sliding hernial recurrences are to be prevented.

14. In the 369 repairs of recurrent hernias carried out at this hospital (up to March 3, 1951) the only significant effects from immediate early postoperative ambulation have been beneficial.

15. If the femoral region is checked at the time of the initial operation and any necessary repairs then are carried out, there is no evidence in this study to suggest that a hernial repair with Cooper's ligament has any advantages over one with Poupart's ligament.

16. A 10 year follow-up is desirable in assessing hernial repairs.

17. Improvement in repairs of recurrent hernias can be obtained without the use of extraordinary methods but rather through the utilization of sound principles of plastic surgery combined with a thorough anatomic knowledge of the regions involved.

18. Recurrences in recurrent hernias repaired less than 1 year previously would seem to be preventable as there were no recurrences within less than a year postoperatively in this series of 369 cases repaired in this hospital, and this despite the fact that our investigations indicated that 66 per cent of the failures in recurrent hernial repairs studied had occurred in the first year postoperatively.

19. A recurrence rate of approximately 1 per cent or less is possible in recurrent hernias. The recurrence rate in this series was 0.8 per cent overall, and 1.3 per cent in the 150 patients actually examined by doctors more than 2 years postoperatively.

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INFLAMMATORY FIBROID POLYPS OF THE STOMACH

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POLYPS of the pyloric antrum are a diagnostic and prognostic problem to clinicians, roentgenologists, gastroscopists, and pathologists. They may be classified as either adenomatous or as one of several nonadenomatous types, but because the clinical manifestations are common to the several different polyps the exact diagnosis can seldom be determined preoperatively. One of the nonadenomatous types is characterized by distinctively arranged fibrous tissue and blood vessels, with an inflammatory infiltrate often dominated by eosinophilic leucocytes. Polyps of this description have been recorded in the literature under such diverse terms as eosinophilic granuloma of the stomach, gastric submucosal granuloma with eosinophilic infiltration, hemangioendothelioma, hemangiopericytoma, neurofibroma, polypoid fibroma, and fibrinous polyp. A study of 10 such polyps was undertaken in an effort, first, to reconcile the discrepancies of interpretation and, second, to establish, if possible, the true nature of the process.

REPORT OF CASES

Because of their microscopic similarities the polyps are described in detail in only the first few case reports.

CASE 1. AFIP Acc. 297945. A 58 year old white man had suffered for 12 years from intermittent attacks of epigastric pain, nausea, and vomiting that lasted for several hours and recurred in from 1 to several weeks. The pain was aching in character and was relieved by vomiting rather than eating. He had lost 12 pounds in the last 2 years. There was no history of bleeding. In 1939 when symptoms were first noted, hemoglobin was 80 per cent, erythrocytes numbered from 3,600,000 to 4,200,000; the total leucocyte count was 17,500, with neutrophils 80 per cent, lymphocytes 18 per cent, and eosinophils 2 per cent. Wassermann and Kahn tests were negative. Gastric analysis revealed total acidity 5 degrees, no free or combined hydrochloric acid, and a large amount of mucus. In 1950 the principal changes in the blood count were a decrease in total leucocytes to 9,700 and an increase in eosinophils (9 per cent). On gastric analysis total acidity was 10 degrees; free hydrochloric acid was absent. After histamine, total acidity was 12 degrees with no free hydrochloric acid in the first specimen, and total acidity 9 degrees and free hydrochloric acid absent in the second. The stools were negative for parasites, occult blood, ova, blood cells, protozoa, nematodes, and mucus. Fluoroscopic and roentgenographic studies of the gastrointestinal tract in 1939 revealed no definite changes. Similar studies in 1950 showed stiffening of the walls of the pyloric antrum and persistent indentation and incisura on the side of the greater curvature. Antral gastritis and a malignant lesion were suggested as possible interpretations. Gastroscopic examination disclosed a polyp on the lesser curvature of the stomach distal to the angle. Subtotal resection was carried out, and a year later there was a normally functioning gastrojejunostomy. On gastric analysis the total acidity was 10 degrees and there was no free hydrochloric acid.

Pathologic observations. The resected portion of the stomach measured 15 centimeters along the greater curvature. There was a fingerlike projection, approximately 1.5 by 5 centimeters, apparently covered by thin mucosa. Microscopically, the core of the polyp was composed of fibrous tissue generally disposed as loose thread-like fibrils arranged irregularly in parallel rows or in concentric pattern about blood vessels (arterioles and capillaries). The nuclei were predominantly thin and fusiform, occasionally plump and oval. The finer fibrils stained with Gridley's reticulum stain and the coarser ones as collagen in Masson and van Gieson preparations. The fine fibrils were often separated by small clear spaces in hematoxylin and eosin preparations. The connective tissue of the polyp at the base extended to the muscularis mucosae, and laterally to and into the basal zone of the mucosa; over the dome it formed the base of an ulcer. The blood vessels varied in size, number, and mural thickness. Many were surrounded by concentric layers of fibrillar connective tissue which produced bizarre tissue patterns when the plane of section was tangential through a tortuous vessel.

A moderately dense inflammatory infiltrate, composed chiefly of eosinophilic leucocytes, but including plasma cells and lymphocytes, was distributed throughout the polyp. There were also a few follicle-like collections of lymphocytes. The inflammatory

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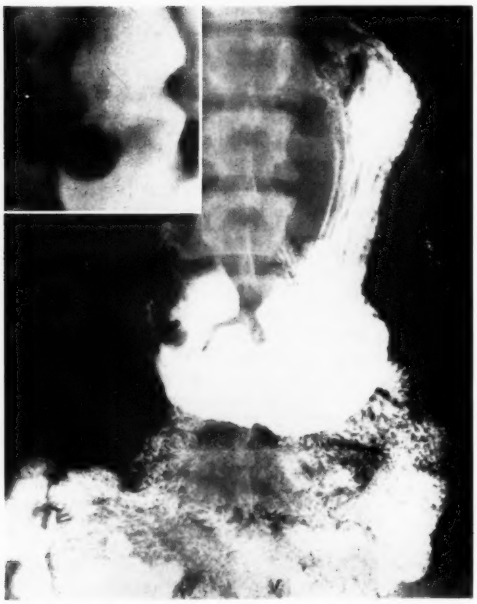

Fig. 1. Case 2. Roentgenogram showing polyp of pyloric antrum.

cells were less dense in the central area but otherwise were diffusely distributed and exhibited no predilection for the perivascular zones.

The mucosa of the stomach was continuous with that covering the polyp. In the angles at the base of the polyp the mucosa was relatively thick but otherwise normally disposed. As the mucosa approached the dome of the polyp it gradually became attenuated and then ulcerated. The ulceration at the apex of the lesion possessed a floor of well vascularized granulation tissue which was infiltrated with eosinophils, plasma cells, and lymphocytes. The mucosa covering the polyp and contiguous to it contained many plasma cells. Simplification of many mucosal glands in the adjacent mucosa was observed. The muscularis mucosae passed beneath the lesion and except for slight thickening was not unusual. The submucosal veins were dilated and hyperemic.

CASE 2. AFIP Acc. 332975. A 35 year old white man had a 6 year history of generalized malaise, glossitis, weakness and anemia, subsequently interpreted as pernicious anemia. For 3 years he had experienced rather sharp, intermittent epigastric pains not related to food intake. There were a few episodes of nausea and vomiting, especially after meals. The initial hemogram was erythrocytes 1,740,000; total leucocytes 3,000, with 38 per cent neutrophils, 60 per cent lymphocytes, 2 per cent monocytes, and the hemoglobin was 5.25 grams. Gastric analyses at this time disclosed no free hydrochloric acid and a high total acidity of 5 degrees. Fecal examinations disclosed neither ova nor parasites. Serologic reactions for syphilis were negative. There was no history of allergy, but the patient disliked eggs and ate only such meats as hamburger and ground mutton. An antral gastric polyp was noted on gastroscopy. A round polypoid mass, approximately 1 centimeter in diameter, in the antrum of the stomach just proximal to the pylorus was seen on roentgenologic study and repeatedly on fluoroscopy. A subtotal gastric resection was performed.

Pathologic observations. In the stomach there was moderate atrophy of the mucosa with only a few rugae localized to the upper half. A sessile polyp, 2 by 1.5 by 1.5 centimeters, was located at the lowermost inch of the stomach. The polyp was soft with a firm white area at the base. On cut section the submucosa of the distal half of the stomach appeared thin. Microscopically, the polyp was comprised of a central mass of delicate fibrillar and connective tissue contiguous with and covered by mucosa. The lesion externally was limited by the mucosa and at the base by the deeper part of the submucosa. The muscularis mucosae at the angles of the base split into several bundles, and many small fragments of muscle were present throughout the polyp. There was no perceptible tendency for the fibrillar tissue to surround blood vessels, but it often paralleled or encircled the split bundles of muscularis mucosae. The inflammatory cell infiltrate was densest in the mucosa over the dome of the polyp and in the contiguous fibrillar tissue and at the base. In the mucosa over the polyp plasma cells predominated, whereas within the polyp eosinophilic leucocytes were most common.

CASE 3. AFIP Acc. 174438. A negro man, 22 years of age, died from the effects of a craniocerebral injury sustained in a fall 59 hours previously.

Pathologic observations. The pylorus of the stomach presented a small, raised, flat tumor, 1.8 by 0.5 centimeter. It was difficult to discern whether the tumor arose from the basal mucosa or lamina propria. Microscopically, the polyp differed from those described in that the connective tissue was not disposed in concentric or perivascular arrangement. The lesion extended into the deeper submucosa from which it was poorly delimited. It was diffusely infiltrated with eosinophilic leucocytes which were slightly more numerous peripherally. The muscularis mucosae followed the mucosa on to the margins of the polyp and then split into numerous small bundles. Particularly at the apex, the muscle bundles were separated by the substance of the polyp which continued into the base of the mucosa. The mucosa at the margins of and covering the polyp was infiltrated with plasma cells. At the apex of the polyp was a small focus of ulceration. Blood vessels at the base of the polyp were dilated and hyperemic and those within it ranged from small and well formed, to thin dilated channels. The muscularis beneath the polyp was thickened.

CASE 4. AFIP Acc. 67221. A white man, aged 63 years, in 1936 had noted distention of the abdomen and belching of gas. Five months before admission to the hospital in 1940, added symptoms were attacks of pain in the abdomen and across the epigastrium, radiating, at times, to the left side of the chest and sternum. He had an intolerance to fried and fatty food. There was no constipation. He had lost 15 pounds in weight.

Physical examination disclosed tenderness in the midline from the xyphoid process to 4 centimeters below the umbilicus, most acute 5 centimeters above the umbilicus. The liver was palpable and slightly enlarged. The red blood cell count was 3,850,000 to 4,550,000; hemoglobin was 78 per cent; white cell and differential counts were within normal limits. Kahn tests and urinalysis were negative, and the feces were positive for occult blood. Examination of the gastric contents showed free hydrochloric acid only in a terminal rise of 10 degrees. A roentgenologic study of the gastrointestinal tract revealed a rather large polyp in the pyloric end of the stomach. On gastroscopic examination the polyp was not seen, but there was a grayish mound suggestive of neoplasm in the pyloric end of the stomach. A subtotal gastrectomy was done. Pernicious anemia became apparent in 1947 but responded to treatment until 1951, when jaundice developed. The patient died in April 1951 and no autopsy was obtained. The clinical diagnoses were obstructive jaundice and myocardial infarction.

Pathologic observations. The specimen from the operation performed in 1940 was spherical and about 4 centimeters in diameter, covered with gastric mucosa, and attached by a long pedicle 2 millimeters in diameter. Microscopically, several sections of the polyp were composed of loose reticular and fibrous tissue which extended into, among, and occasionally concentrically about the glands of the mucosa. The mucosa was partially ulcerated, and at the base of the ulcers the well vascularized granulation tissue was continuous with the reticular tissue. Throughout the polyp were numerous vessels, some with a thin smooth muscle layer and others with only an endothelial lining. Most of the vessels were surrounded by concentric layers of fine reticular tissue with intervening minute clear spaces. The inflammatory infiltrate was predominantly eosinophilic. Only a few tiny bundles of smooth muscle were noted within the polyp. In a section of gastric wall away from the polyp, furrows in the mucosa were prominent; the glands tended toward simplification, and the stroma exhibited various degrees of edema and infiltration of plasma cells, lymphocytes, and a few eosinophilic leucocytes. The inflammatory infiltrate involved areas of the muscularis mucosae and submucosa.

CASE 5. AFIP Acc. 286664. A white man, 65 years of age, was noted to have a polyp of the stomach in the course of roentgenographic study to discover the cause of his anemia. It was classified as pernicious and the patient responded well to liver therapy. No symptoms were referable to the polyp except vague complaints of indigestion in recent months. In addition to anemia the patient had hypertension. On October 27, 1947 a pedunculated polyp was excised through the base. It was attached to the greater curvature, 4 centimeters from the pylorus, by a pedicle 2.5 centimeters in length. The base was attached neither to the underlying submucosa nor to the muscularis. The polyp was not

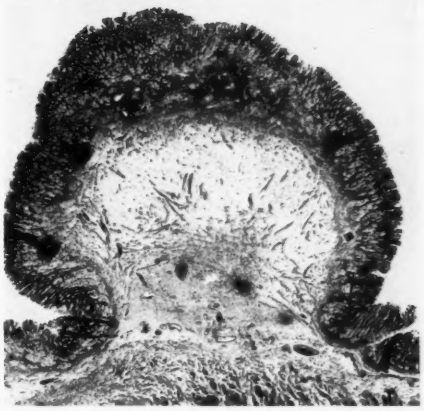

Fig. 2, above. Case 2. Solitary sessile polyp covered with mucosa.

Fig. 3, below. Case 2. Hemisection of sessile polyp in Figure 2. The muscularis mucosae splits into numerous bundles dispersed throughout polyp. Denser apical and basal zones are diffusely infiltrated with inflammatory cells. Foci of lymphocytes are most plentiful near mucosa. Blood vessels at base of lesion are dilated. Hematoxylin and eosin, ×7.

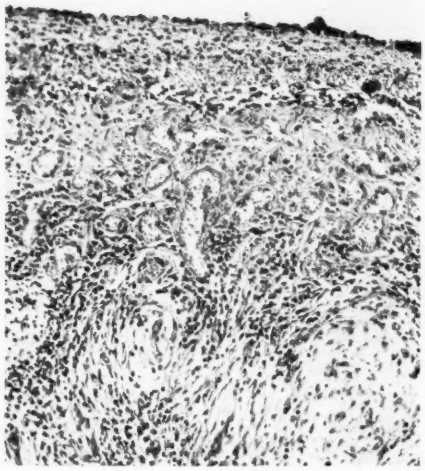

Fig. 4. Case 4. Section through ulcerated area at apex of polyp in Figure 5. Beneath a layer of surface exudate and fibrin is well vascularized granulation tissue continuous with fibrillar core of polyp. Many inflammatory cells are eosinophilic leucocytes. Hematoxylin and eosin, ×97.

Fig. 5. Case 4. Solitary pedunculated polyp in the pylorus covered by mucosa except in apical area of ulceration. Mucosal folds of stomach near the base of the polyp are pronounced; elsewhere the mucosa exhibits a mosaic pattern.

unduly hard or indurated, nor was its surface ulcerated.

Pathologic observations. The specimen consisted of a polyp, 2.5 centimeters in diameter, with a wide cuff of gastric wall. Microscopically, several partial sections of the polyp were covered with gastric mucosa which was focally edematous and moderately infiltrated with plasma cells and eosinophilic leucocytes. The polyp was composed of coarse, fibrillar, collagenous connective tissue arranged in a parallel or irregular, but seldom a concentric pattern. The muscularis mucosae was absent immediately beneath the mucosa over the polyp, or scattered bundles were separated by the substance of the polyp. There was diffuse infiltration of inflammatory cells, mostly eosinophilic leucocytes.

Case 6. AFIP Acc. 232721 (Sawyer and Lubchenco, 21). A 90 year old man had noted anorexia and vomiting. Two weeks before admission to hospital, following a spell of coughing, he was aware of a feeling of epigastric fullness and the vomitus occasionally was blood streaked. A roentgenogram of the upper intestinal tract revealed a constrictive lesion of the distal end of the stomach, suggestive of carcinoma. A subtotal gastric resection was performed and the patient was well 3 years later.

Pathologic observations. A hard, rather smoothly outlined polypoid mass, 5 centimeters in diameter, with an ulcerated surface, was attached by a pedicle, 2.5 centimeters in length and 1.5 centimeters in diameter, to the anterior wall of the stomach, 1 centimeter proximal to the pyloric ring and midway between the curvatures. The pedicle was covered with normal mucosa that formed a bridging effect with the contiguous gastric mucosa. Microscopically, the pattern in sections of the polyp was similar to that described in Case 1. Much of the mucosa was ulcerated and the underlying granulation tissue was continuous with the tenuous fibrillar tissue of the polyp. The meshwork of fibrillar tissue showed fields of parallel cellular arrangement as well as a concentric perivascular pattern. Eosinophilic leucocytes composed the largest part of the infiltrate. The muscularis mucosae was absent except beneath the intact mucosa. Both small and larger thin-walled vessels usually had either a thin muscular coat or none at all.

Case 7. AFIP Acc. 271222. A 59 year old white man with diabetes died of coronary thrombosis. No signs or symptoms had been referable to the stomach. The patient consumed 1 pint of alcohol daily.

Pathologic observations. Autopsy revealed severe coronary and generalized arteriosclerosis. The stomach was normal except for a raised pedunculated polypoid projection, 1 centimeter in diameter, interpreted grossly as a benign papilloma. In a microscopic preparation of a hemisection of the lesion and the contiguous gastric wall, the body of the polyp was made up of fibrillar tissue arranged in an irregular pattern. The external layer of the muscularis mucosae formed the base of the lesion and the internal layer was divided into several separated bundles within the polyp. At the apex of the polyp the mucosa was ulcerated. The inflammatory infiltrate was predominantly plasma cells. Blood vessels were small and of capillary type. Otherwise the polyp resembled those more fully described.

Fig. 6.

Fig. 7.

Fig. 6. Case 4. Junction of mucosa and fibrillar tissue of polyp. Note bizarre pattern of fibrillar tissue. Hematoxylin and eosin, ×78.

Fig. 7. Case 4. Fibrillar tissue is disposed in strands parallel to a blood vessel. Hematoxylin and eosin, ×148.

CASE 8. AFIP Acc. 492493. A 68 year old white man was admitted to the hospital with virus pneumonia and arteriosclerotic heart disease with early decompensation. Initial studies of the blood disclosed 4,800,000 red blood cells; hemoglobin 12.5 grams; a total leucocyte count of 10,000, with 54 per cent neutrophils, 43 per cent lymphocytes, and 3 per cent eosinophils. Twenty days after admission the red blood cells had declined to 3,400,000 and the hemoglobin to 10 grams. Three stools examined for occult blood were positive. A gastric analysis showed no free hydrochloric acid after histamine was injected. A roentgenologic gastrointestinal study suggested cancer of the stomach, but the patient died before the studies could be repeated.

Pathologic observations. The autopsy failed to confirm the clinical impression of coronary and myocardial disease, although the heart weighed 550 grams. Decompensating heart disease and renal failure were regarded as the causes of death. Located in the mucosa of the antrum of the stomach, 3 centimeters above the pyloric sphincter, was a sharply elevated nodule, 1.5 centimeters in diameter. The base was slightly constricted and the mucosa covering the lateral aspects and base was soft, while that covering the summit showed an ulcer 5 millimeters in diameter. Fifteen millimeters from the ampulla of Vater was a submucosal nodule of pancreatic tissue, 5 millimeters in diameter. A subserosal leiomyoma, 17 by 20 millimeters, was noted in the ileum. There were diverticula of the colon.

Microscopically, the polyp of the stomach was composed of coarse fibrillar connective tissue. The lower margin was unencapsulated but was limited by the deeper submucosa, and the external surface was covered with mucosa. The muscularis mucosae extended up along the margins of the polyp to the apex where it separated into scattered minute bundles. The mucosa of the stomach and over the polyp was infiltrated with many plasma cells and a few eosinophilic leucocytes.

CASE 9. AFIP Acc. 107730. A negro male, 29 years of age, for 6 years had suffered from pain in the epigastrium which came on about 1 hour after eating. Neither food nor soda gave relief and highly spiced foods aggravated the pain. Occasional nausea was not accompanied by vomiting. A primary syphilitic lesion of the penis was noted in December 1942. X-ray examination, June 1943, disclosed a normal esophagus, stomach, and first portion of duodenum. There was no evidence of 6 hour gastric residue. In December 1943 the patient began to

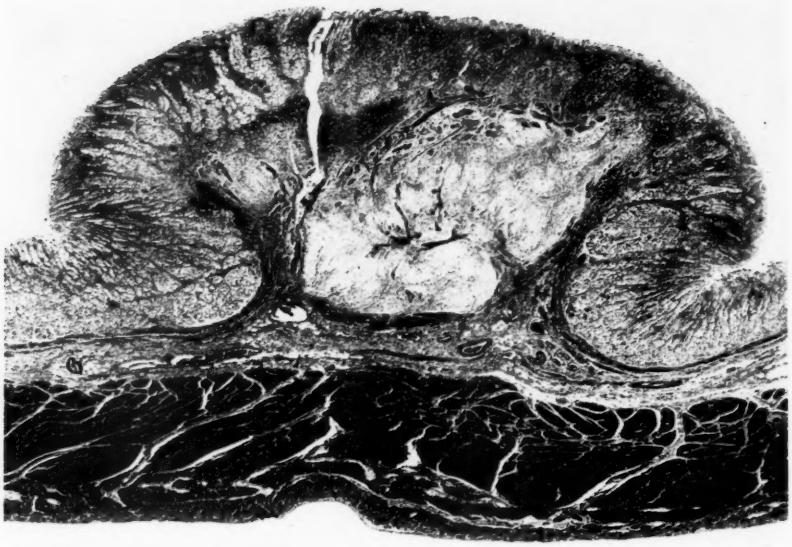

Fig. 8. Case 7. Hemisection of a sessile polyp. Mucosa appears thickened in angles laterally, but attenuated and infiltrated with inflammatory cells at apex. The muscularis mucosae extends into margins and then frays out. Hematoxylin and eosin, ×12.

suffer from severe, intermittent griping pain in the right lower quadrant and around the umbilicus. The pain had no relation to food intake or bowel movements. X-ray study revealed a polypoid growth near the pylorus. On January 18, 1944, the gastric polyp was removed surgically. The abdominal lymph nodes and the nodes along the course of the common bile duct were enlarged by a granulomatous process suggestive of either tuberculosis or Boeck's sarcoid. The postoperative course was uneventful except for generalized lymphadenopathy. In March 1944, hemoglobin was 80 per cent, red blood cells numbered 4,560,000; white blood cells, 6,250, with neutrophils 53 per cent, lymphocytes 33 per cent, and eosinophils 14 per cent. Ova of Necator americanus were present in the feces. An inguinal node and an epitrochlear node removed from the left side in April 1944 were diagnosed Boeck's sarcoid. In May 1944, the patient complained of vague, indefinite abdominal symptoms, more or less similar to those which he had before the operation. Sputum examinations were negative; blood Wassermann was negative; erythrocyte count was 4,530,000; total leucocyte count 5,000. Other than enlarged lymph nodes, particularly in the inguinal areas, the physical examination was negative. The abdominal symptoms, which he described as dull "discomforting" pain in the midline of epigastrium, were still prominent when he was examined in 1947. The lymph nodes in the inguinal and femoral chains were firm and indurated. The same gastric complaints were present in 1951.

Pathologic observations. A sessile polyp, measuring 1.1 by 1.6 centimeters, was composed of fibrillar connective tissue separating bundles of muscularis mucosae which extended into the base of the mucosa. The lesion was diffusely infiltrated with eosinophilic leucocytes, and the mucosa contained a large number of plasma cells. Blood vessels tended to be small with relatively thick walls. No changes suggestive of sarcoid were observed in the polyp.

CASE 10. AFIP Acc. 336298. A 47 year old white woman complained for 5 months of epigastric pain that came on 2 hours after eating and was associated with weakness and dizziness. A glass of milk relieved the pain. The roentgenogram showed a spherical space-taking lesion, about 2 centimeters in diameter, in the prepyloric region of the lesser curvature of the antrum. It was movable and did not obstruct the flow of barium into the duodenal cap, although there was some gastric retention. Polyp, aberrant pancreas, myoma, and malignant tumor were possible diagnoses. Gastric analysis showed a total acidity of 10 degrees and no free hydrochloric acid in the fasting specimen, and 20 degrees total acidity and 4 degrees free hydrochloric acid in the only other specimen examined. The total leucocyte count was 7,700 with 59 per cent neutrophils; hemoglobin was 12 grams, and no count was made of the erythrocytes.

The polyp on the lesser curvature noted on roentgen examination was not confirmed gastroscopically, but a polyp was present on the greater curvature and

Fig. 9.

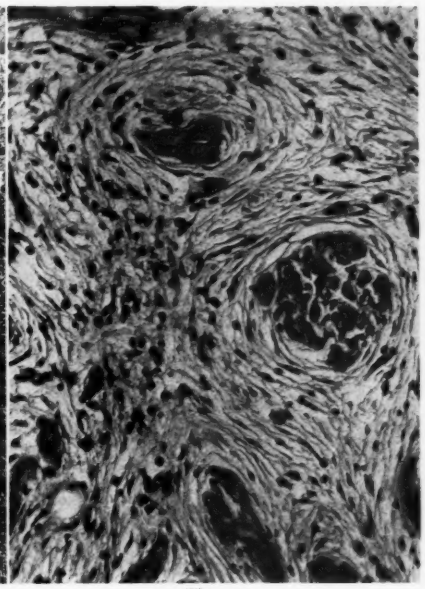

Fig. 10.

Fig. 9. Case 7. Junction of polyp and submucosa shown in Figure 8. Hematoxylin and eosin, ×42.
Fig. 10. Case 2. Loose, fine, fibrillar connective tissue arranged concentrically about frayed and displaced fragments of muscularis mucosae. Hematoxylin and eosin, ×191.

another poorly demarcated polyp on the mid-portion of the stomach. A polyp located anteriorly and 3 centimeters proximal to the pyloric vein was excised with a cuff of gastric wall 2 centimeters wide. Examination of the rest of the stomach through the gastrotomy wound was negative. The polyp was found to be benign when it was examined in frozen section.

Pathologic observations. The polypoid mass measured 3 by 3 by 1.5 centimeters and at the tip there was an ulcer, 1 centimeter in diameter, with a rubbery brownish-appearing nodule protruding through its base. On cut section the nodule extended downward 1.5 centimeters to a yellowish gray base. Microscopically, the polyp was made up of fibrillar tissue arranged irregularly and sometimes concentrically about blood vessels and minute bundles of smooth muscle. Numerous small blood vessels, like those of granulation tissue, were more abundant in some areas than in others, especially at the base there was more collagen and fewer blood vessels. Infiltration of eosinophilic leucocytes was diffuse, sometimes accompanied by plasma cells and lymphocytes. Occasionally the infiltrate was more concentrated about blood vessels. A few endothelium-lined spaces contained pink homogeneous material. Over much of the surface the mucosa was ulcerated and these areas were infiltrated with plasma cells and eosinophilic leucocytes.

DISCUSSION

Clinical features. The patients in our series were from 22 to 90 years of age, all but 2 being more than 47 and the largest number in the seventh decade. Pain was the most prominent symptom, occasionally accompanied by nausea and vomiting. In some instances symptoms of intermittent pyloric obstruction suggested a ball-valve action of the polyp. Absence of or low levels of free hydrochloric acid were noted in every patient in which gastric analysis was performed; 2 patients had pernicious anemia, and a third unexplained anemia. Portis and King have stated that histamine-free achlorhydria increases after the age of 45. These authors found achlorhydria in 9.8 per cent of 113 patients without organic abnormality of the gastrointestinal tract, and they maintain that this is about the frequency of achlorhydria in the population as a whole. Only 1 of our patients with hypoacidity was younger than 47 years. Vaughan, Gunter, and Erwin, in a study of 38 patients with enlarged and tortuous gastric folds,

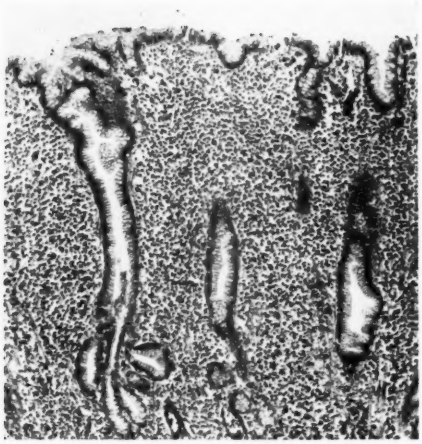

Fig. 11. Case 9. Mucosa over polyp. Attenuation and separation of glands by dense inflammatory cell infiltrate. Hematoxylin and eosin, ×57.

found 12 patients with complete absence of free hydrochloric acid, 8 with hypoacidity, and 10 with hyperacidity. Yarnis, Marshak, and Friedman noted achlorhydria in 91 per cent of 55 patients with adenomatous polyps of the stomach. In their opinion the achlorhydria was associated with an atrophic gastric mucosa. The absence of free hydrochloric acid apparently has no bearing on the specific type of polyp.

A gastric lesion was noted in 8 of the 10 patients examined roentgenologically; in 6 it was interpreted as a polyp (Fig. 1), and in 2 as a possible carcinoma. Seven of the polyps were removed surgically: 4 by subtotal gastrectomy and 3 by local excision. Two were incidental observations at autopsy.

Gross pathologic features. In 9 of our patients the anatomic location of the polyp was specified as the pyloric antrum. Although the polyps were single in each of our patients, we have reviewed an unpublished case (20) in which a polyp of the pylorus and one elsewhere were observed at autopsy in a 60 year old white man. The polyps in our cases were chiefly submucosal, although the deeper zone of the mucosa was involved in some instances. The base was located above the muscularis mucosae or extended into the submucosa. Most of the polyps were sessile, a few pedunculated, and they ranged from 1 to 5 centimeters in diameter (Figs. 2, 3). They were covered with mucosa continuous with that of the gastric wall. Areas of ulceration (Fig. 4), principally of the apex, were seen in 7 specimens. Prominent ridges in the gastric wall radiated from the base of some of the polyps (Fig. 5). As described at operation the polyps were soft or rubbery and fixed to the mucosa but not to the true muscularis. The cut surface was grayish pink and translucent.

Microscopic characteristics. Our observations indicate that the polyps in the 10 cases reported are essentially similar. They are characterized by the presence of fibroblastic, reticular, and fibrillar connective tissue, blood vessels varying in size and mural thickness, and infiltration of inflammatory cells in various proportion, with eosinophilic leucocytes usually predominant (Figs. 6 to 17). This description conforms with that detailed by a number of authors for a gastric lesion to which they have given a variety of names: granuloma with eosinophilic infiltration (Vanek), eosinophilic granuloma (Booher and Grant), hemangiopericytoma (Stout), hemangioendothelioma (Sawyer and Lubchenco), a typical schwannoma (Lortat-Jacob and Moricheau-Beauchant), neurofibroma (Feyrter), and fibroma (Konjetzny). It is also possible that the polyps we have studied are similar to the inflammatory pseudopolyp described by Schindler and McGlone, the fibrinous polyp, by McLaughlin and Conlin, and the fibroma, by Eliason and Wright.

Pathogenesis. The pathogenesis of grastric polyps of the type described has been variously interpreted.

Neurogenous. The initial diagnosis of some of our cases, as of a number reported in the literature, was neurofibroma or neurilemmoma. The onion skin or concentric pattern of loosely arranged, wavy, fibrillar connective tissue about the walls of blood vessels, especially those with hardly discernible lumens, has been likened to the appearance of pacinian corpuscles. When the section includes only the outer layers of a tortuous vessel, change of this type simulates a Wagner-Meissner corpuscle. Such an interpretation is untenable for the following reasons. Unlike the pacinian

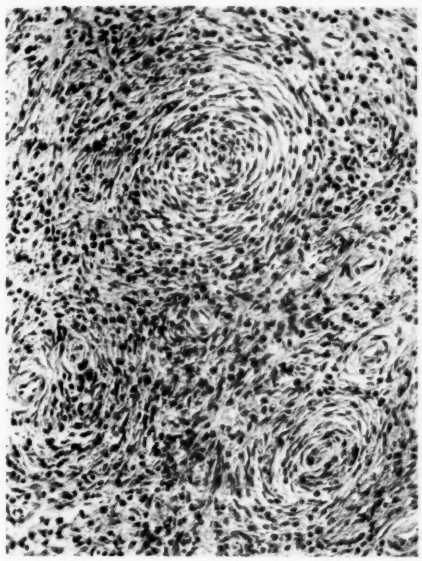

Fig. 12. Case 1. Fine fibrillar connective tissue is disposed concentrically about small blood vessels, producing an onion skin effect. Eosinophilic leucocytes are scattered throughout. Hematoxylin and eosin, ×145.

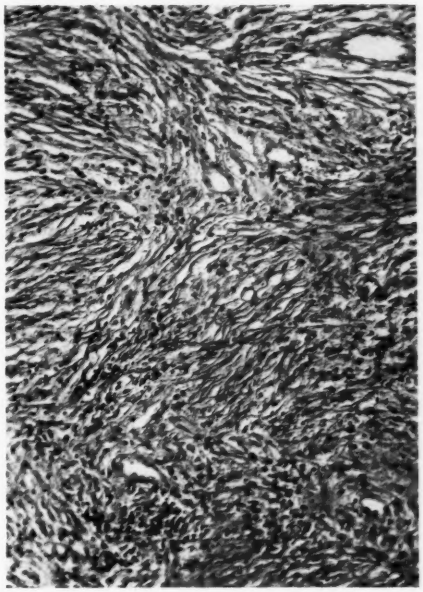

Fig. 13. Case 5. The fibrillar connective tissue is relatively coarse and it is arranged irregularly rather than concentrically about the blood vessels. Hematoxylin and eosin, ×110.

and Wagner-Meissner corpuscles the concentric structures have occurred around small blood vessels of varying development or about bundles of displaced muscularis mucosae. The concentrically arranged fibrillar tissue varies from a fine reticular type to a coarse variety which stains as collagen. In the majority of the specimens the connective tissue is either irregularly disposed without relationship to any structure or, as in a few cases, it is aligned more or less parallel to bundles of muscularis mucosae. Nerves were not identified in association with any of the concentric structures, and axis cylinder processes were not encountered in Bodian preparations. The latter observation would seem to eliminate as a possible source of the polyp the traumatic neuroma which sometimes occurs at the base of a gastric ulcer.

Vascular. The pattern regarded by some workers as indicative of a neurogenous lesion has been interpreted by others as evidence of hemangioendothelioma or hemangiopericytoma. The elongated cell in the concentric layering about some of the blood vessels has been likened to the pericyte. The small centrally placed vascular channels and surrounding concentric cellular pattern has been interpreted as angiomatous. Both interpretations seem unwarranted. If this peculiar vascular structure were basic to the lesion it should be present in all examples, but it was seen in only some of the polyps. Not only among all the specimens, but sometimes within a single specimen, the fibrillar tissue varied from a reticular type to a collagenous type. This increase in collagenous tissue is interpreted as evidence of maturation in a healing inflammatory process. It would seem unlikely that a pericytoma or hemangioendothelioma would undergo such changes. Furthermore, reticulum preparations do not bring out the pattern described by Stout (23) as essential for the diagnosis of hemangiopericytoma.

Allergic. Infiltration of inflammatory cells, including various numbers of eosinophilic leucocytes, plasma cells and lymphocytes, both scattered and in solitary collections, was

Fig. 14.

Fig. 15.

Fig. 14. Case 10. Hemisection of polyp. Ulceration at apex. Hematoxylin and eosin, ×4.
Fig. 15. Case 10. Enlargement through mucosa of Figure 14. Glands are separated and simplified. Delineation of mucosa and polyp is obscure, ×42.

present in all the polyps. In general, the greater the collagenous element in the stroma the fewer the inflammatory cells. The presence of the eosinophilic infiltration has been the basis for the contention that the lesion is of allergic origin. However, in no instance among the patients previously reported has there been clinical evidence of hypersensitivity and in none of our patients was such evidence noted. Eosinophilic infiltration is not unique to the inflammatory fibroid polyp since it is also sometimes observed in the stroma about peptic ulcers. On the basis of the present evidence it would appear that hypersensitivity as determined by clinical examination of the patients is not a factor in the production of the eosinophilia.

The lesion with thickening of the pylorus and band-like thickening of the small bowel described by Herrera and Guardia and the lesion with thickening of the pylorus, duodenum and first 2 feet of the jejunum described by Barrie and Anderson do not appear similar morphologically to the lesion in the case reported by Booher and Grant, although such a claim was made. A high blood eosinophilia, together with gastrointestinal eosinophilia, was taken to indicate a possible allergic background in the first 2 cases cited. Tissue eosinophilia in a jejunal granuloma was similarly interpreted by Polayes and Krieger. Increase in the number of eosinophils, both in the blood and in the intestinal tract, should be interpreted with caution because of the many possible causative factors. Necrosis of eosinophilic exudate, "fibrinoid" collagen change and granulomatous proliferation of epithelioid and giant cells considered by Churg and Strauss to be a histopathologic entity, which they termed "allergic granuloma," was not seen in our cases. There seems to be no justification for interpreting the lesion we have described as of allergic origin on the basis of the eosinophilia, even though eosinophilia is often part of an allergic reaction.

Eosinophilia and pernicious anemia. Eosinophilia of the blood has been noted by Wintrobe in patients with pernicious anemia following therapy with liver or stomach extract. He has also observed eosinophilia as high as 28 per cent in the blood of untreated patients with anemia of this type. In this connection it is of interest that the original diagnosis in 2 cases of our series was pernicious anemia, but neither of the patients had eosinophilia of the blood. The abundance of eosinophils in the polyps from our patients without anemia can certainly not be explained as an ac-

Fig. 16.

Fig. 17.

Fig. 16. Case 10. Fine fibrils stain as reticulum. Gridley reticulum stain, ×65.
Fig. 17. Case 10. Thick walled blood vessel with mantle of coarser fibrillar tissue. These coarse fibrils stain as collagen. Hematoxylin and eosin, ×309.

companiment of anemia. Only 1 of our patients had appreciable eosinophilia of the blood, 14 per cent in Case 9, and this could be explained by the presence of Necator americanus in the stools.

In this connection the association of adenomatous polyps of the stomach, solitary and multiple, with pernicious anemia has been recognized, but there is no mention in the literature of the coexistence of inflammatory fibroid polyps and pernicious anemia. In Brown's series of patients with pernicious anemia, there were 12 with benign tumors of the stomach, 3 classified as myomas and 9 as polyps. Whether any of the polyps were similar to those in the present study is not known. Of the reports of cases apparently similar to ours in the literature, there was none in which pernicious anemia was noted as a factor. It is possible that the diagnostic blood changes in some of the patients could have been obscured by self-administration of vitamins (Conley and Krevans). The presence of pernicious anemia in 2 of our patients is difficult to evaluate. A possible explanation may be that the associated gastritis in this type of patient predisposes to the development of the inflammatory fibroid polyp.

Inflammatory nature of polyps. None of the designations used for the lesion under discussion is entirely satisfactory. The use of the term granuloma in reference to this lesion is objectionable because of its diverse connotations. Granuloma is used not only to indicate tumor-like granulation tissue but also a tuberculoid reaction and even Hodgkin's disease. Eosinophilic granuloma may be interpreted literally as pink-colored, tumor-like granulation tissue or as a granuloma with eosinophilic leucocytes as seen in parasitic granulomas and in eosinophilic granulomas of bone and skin—lesions with established priority on this name. On the basis of the present observations all names indicating that the lesion is a tumor are not acceptable. We believe the designation "inflammatory fibroid polyp" is

the most satisfactory until a name can be established on the basis of the exact etiology. The term polyp is commonly used to describe any benign growth, either sessile or pedunculated, arising from the mucous membrane. For the purpose of exact classification this gross term must be qualified by adjectives based on precise histologic structure (Helwig). The adjective "inflammatory" has been used to indicate the inflammatory nature of the lesion and "fibroid" to indicate its fibrous character and that it simulates a fibroma. The inflammatory fibroid polyp should always be differentiated from the adenomatous polyp, for the latter is probably a premalignant lesion. It is immediately apparent that the correct treatment and prognosis of polyps of the stomach cannot be developed on the basis of the nonspecific diagnosis of gastric polyp.

Even though the pathologic changes and the natural history of the lesion indicate an infectious etiology, no specific agent could be adduced from this study. In most of the specimens only the gastric mucosa covering the lesion and the contiguous margin of the stomach were available for study. The mucosa, particularly over the lesion, usually showed an increase of plasma cells and lymphocytes and in some instances there was attenuation of the glands. Hebbel examined stomachs of persons without manifest gastric disease for evidence of chronic gastritis and observed such lesions in 72 per cent. It is of interest in relation to the present study that the changes of chronic gastritis encountered by him ranged from a focal to a diffuse process. On the basis of his observations the lesion seen in our cases might occur at the site of localized gastritis without similar change elsewhere in the stomach. Cox (6) recorded almost complete replacement of the normal mucosal glands of the stomach in 6 patients with pernicious anemia although the pyloric zone was only slightly altered. However, single polyps occurred in the pyloric zone in 2 patients. He has allowed us to study these 2 lesions which, although containing a few inflammatory cells, are of the adenomatous variety (7). Two of our patients had pernicious anemia and 1 patient gave a history of alcoholism. Gastritis is a common accompaniment of both lesions and may have been an etiologic factor of the polyps.

The exudative reaction observed in our specimens is similar in most respects to that noted by Vaughan, Gunter, and Erwin in stomachs with enlarged gastric rugae. A stromal response similar to that observed in our cases was not described by these workers. One polyp reported by Vanek arose at the border of a "calloused ulcer," but in none of our specimens or in other recorded cases was there evidence that the polyp was associated with an old ulcer.

The gross shape of the inflammatory fibroid polyp of the stomach is similar to that of granuloma pyogenicum occurring on the skin and squamous mucous membrane. It is conceivable that the inflammatory fibroid polyp of the stomach is the glandular membrane counterpart of this lesion and that the dissimilarity of morphologic detail is due to basic differences in the stroma of the two sites. Kerr stated that granuloma pyogenicum arises as a result of minor trauma, with a localized overgrowth of granulation tissue and an exaggerated endothelial proliferation. Mock described nonspecific infective granuloma of the gastrointestinal tract in which he postulated a continuing slow necrosing process and a corresponding increase in the reparative process. However none of his specimens was exactly similar to ours.

Once the inflammatory fibroid polyp is formed there can be no doubt that it is enlarged by mechanical action of the food content of the stomach and the peristaltic waves. The increase in the muscularis mucosae within some of the polyps and the occasional thickening of the true muscularis underneath the lesions are also probably due to peristaltic action. The ulceration on the apex of the polyps might be due either to interference with the blood supply of the mucosa of this region or mechanical or chemical action from within the gastric lumen, or to a combination of factors.

Additional evidence that the lesion is inflammatory and not neoplastic is provided by the splitting and fraying rather than the pushing aside of the bundles of hypertrophied muscularis mucosae and the almost imper-

ceptible transition to the nonglandular tissue of the mucosa. That the connective tissue in various regions and organs of the body has different functions and growth potentialities is generally accepted. It is conceivable that the peculiar arrangement and type of reticular and connective tissue observed in some of the polyps is the result of stimulation and growth of a special type of connective tissue that permits peristalsis.

Seven of the polyps herein reported were removed surgically, 4 by subtotal gastrectomy and 3 by resection. No patient has died as a result of recurrence of the gastric lesion. In view of these data it would seem advisable to establish a diagnosis by examination of frozen sections and resect the polyp, if it is inflammatory, rather than to perform the much more serious operation of subtotal gastrectomy.

CONCLUSION

On the basis of the observations made in this study of 10 patients it is postulated that the polyp of the pyloric antrum represents a reaction of the connective tissue of the gastric mucosa, muscularis mucosae and submucosa to some form of inflammatory stimulus. The nature of the stimulus that induces this reaction is not known, but it could be bacterial, chemical, metabolic, or traumatic. On the basis of (1) blood vessels in different stages of development, (2) an intravascular fibrous and reticular stroma of varying maturity, and (3) a nonspecific inflammatory infiltrate, these polyps are interpreted as a special type of granulation tissue response best designated as inflammatory fibroid polyp.

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THE INFLUENCE OF LOCATION ON PROGNOSIS IN OPERABLE RECTAL CANCER

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THERE has been in recent years considerable interest regarding the influence of location on prognosis in rectal cancer. David and Gilchrist, also Waugh and Kirklin, have pointed out that the poorest end results occur with low-lying rectal cancers. Welch and co-authors found no significant difference in prognosis between extraperitoneal and intraperitoneal cancers, nor between lesions at various levels within the extraperitoneal rectum.

In 1922 one of us (G.E.B.) was told by Jerome Lynch that location of a cancer within the rectum had a marked bearing upon prognosis. The lower a lesion was situated within the rectum the poorer the result would be. Although Lynch's conclusion was arrived at by an analysis of perineal types of operations, we accepted it as a fact and at Memorial clinic since that time have performed routinely a very wide perineal resection in all patients, hoping to increase the salvage rate of low-lying cancers. The radical technique has included severance of levator fascia and muscles as close to the pelvic wall as possible and wide removal of perianal skin and perirectal fat. The lateral ligaments were not clamped and seldom were ligated but were always divided close to the pelvic attachments. The perineal wounds were left open as primary closure after such dissection was impossible. Marked care has also been exercised to avoid perforation of the rectum during the dissection, especially at the site of the cancer, lest the wound become infected or cancer cells remain which might result in pelvic implants.

In view of the importance of location on prognosis and the advisability of wide perineal resections in all cases of rectal cancer, we wish to present the variations in 5 year results for lesions at different levels in patients treated by the Miles type of abdominoperineal resection on the rectal and colon service at Memorial Center.

In the years 1928 to 1945 there were 435 abdominoperineal resections performed. During the early years covered in this report, many patients not included were treated by less radical forms of dissection, as well as radiation therapy. Table I indicates the series upon which this report is based. The determinate cases included only adenocarcinoma. Other types of anal and rectal cancer were omitted. There were 369 determinate cases for evaluation of whom 226 or 61.5 per cent survived at least 5 years without evidence of recurrence. It might be mentioned, as has been shown in a previous report (1), that 5 year survivals should not be interpreted as the cure rate, for there will be failures in an appreciable number after the 5 year period has elapsed.

The level of the tumors in this group was evaluated at the time of the preoperative sigmoidoscopic examination. The vast majority of these measurements were made by ourselves and represent a fairly uniform observation with patients in the knee-chest position. For simplicity of review, the rectum has been divided into three sections, measuring from the anal skin margin: (1) the lower section, which includes the anal canal and the lower rectum for a distance of 6 centimeters from the skin margin, (2) the midsection, extending from 6 to 11 centimeters, and (3) the upper segment, from 11 centimeters extending up to include the rectosigmoidal junction. Table II indicates the overall prognosis of lesions in these three locations. Thus, the 5 year survivals of patients with cancer in the lower rectum were 52.8 per cent; in midrectum, 61.8, and in upper rectum and rectosigmoid 72.5 per cent.

TABLE I.—COMBINED ABDOMINOPERINEAL RESECTIONS (1928 TO 1945)

	No. of cases
Total abdominoperineal resections performed	435
Postoperative deaths	22
Died of other causes, or lost track of in less than 5 years without evidence of disease on last visit	28
Unsuitable (lack of clinical data, pathological data, or tumors other than adenocarcinoma)	16
Determinate cases for study	369
Failures less than 5 years	143
Survivors without evidence of disease over 5 years	226
Five year survival of determinate cases, per cent	61.5
Five year survivals of total group (435), per cent	51.9

Duke's classification of the resected specimen also has proved to be of real value in estimating prognosis postoperatively. Table III shows the overall 5 year survivals when specimens were classified according to Duke. The incidence of C lesions in this series is relatively low as compared with our recent group in which a more meticulous search for nodes was made. The 5 year survival rate for the various Duke's classifications is: A, 89 per cent; B, 63.6 per cent; and C, 39.4 per cent.

Table IV correlates the survival rate at various levels with the Duke's classification. The difference in prognosis is particularly noticeable in comparing Duke's B lesions. There were only 44.2 per cent of 5 year survivals in those below 6 centimeters as compared with 64.4 per cent in the midsection, and 79.5 per cent of the tumors above 11 centimeters.

TABLE II.—SURVIVAL AND DISTANCE FROM ANAL MARGIN

Distance cm.	Total No. patients	No. of 5 yr. survivors	5 yr. survival rate, per cent
0–6	121	64	52.8
6–11	172	106	61.8
Over 11	76	55	72.5

TABLE III.—DUKE'S CLASSIFICATION AND SURVIVAL

Class	Incidence of class, per cent	Total No. patients	5 yr. survivors	5 yr. survival rate per cent
A	26.5	98	87	89
B	35.0	129	82	63.6
C	38.6	142	56	39.4

TABLE IV.—SURVIVAL, DISTANCE FROM ANAL MARGIN, AND DUKE'S CLASSIFICATION

Distance, cm.	Class	Total No. patients	5 yr. survivors	Per cent 5 yr. survival
0–6	A	39	33	84.8
	B	34	15	44.2
	C	48	16	35.4
6–11	A	44	40	91.0
	B	56	36	64.5
	C	72	30	41.8
Over 11	A	15	14	93.5
	B	39	31	79.5
	C	22	10	45.5

An attempt was made in Table V to analyze the failures as regards local recurrence or distant metastases without local recurrence in accordance with the various levels as well as in accordance with Duke's classification. It is readily seen that there are too few cases in each group to be significant statistically. However, the tendency for the Duke's B and C lesions in the lower rectum to recur locally within the pelvis is quite marked.

Table VI indicates that in this series there was no appreciable difference of anaplasia of the tumors located at the different levels.

These figures indicate clearly the importance of location on prognosis even following wide perineal dissection. It is only fair to assume that the salvage rate in this group of wide pelvic dissections is much greater than

TABLE V.—LOCALIZATION OF RECURRENCE OR METASTASES

Distance cm.	Class	Total No. patients	Local recurrence		Distant metastases	
			No. of patients	Per cent	No. of patients	Per cent
0–6	A	8	3	37.5	5	62.5
	B	21	14	66.6	7	33.3
	C	27	19	70.6	8	29.4
6–11	A	9	2	22.2	7	77.8
	B	22	11	50.0	11	50.0
	C	44	21	47.8	23	52.2
Over 11	A	1	1	100.0	0	0
	B	10	6	60.0	4	40.0
	C	10	4	40.0	6	60.0

TABLE VI.—INCIDENCE OF GRADES AND FIVE YEAR SURVIVAL AT VARIOUS LEVELS

Distance in cm.	Grade	Incidence per cent	Total No. patients	5 year survivors	Per cent 5 year survival
0–6	i	5.0	6	4	66.6
	ii	56.2	67	37	55.5
	iii	36.1	43	21	48.8
	iv	1.1	3	2	66.6
	ungraded		2		
6–11	i	4.7	8	7	87.5
	ii	59.0	99	68	68.5
	iii	35.0	59	29	49.3
	iv	1.2	2	0	0.0
	ungraded		2		
Over 11	i	2.6	2	2	100.0
	ii	63.2	48	35	73.0
	iii	34.3	26	18	69.0

if conservative surgery had been employed. The site of local recurrence in our cases has been chiefly along the lateral pelvic wall in the region of the obturator space and hypogastric vessels. In a number of males it has occurred in the region of the prostate. Therefore, we believe that many local recurrences were the result of metastatic disease in the lateral pelvic lymph nodes at the time of operation rather than of extension of unremoved local disease in levator muscles, fascia, lateral ligaments, and perirectal fat.

The chief factor upon which we must rely for improvement in the cure of cancer of the rectum is earlier diagnosis. Patients with tumors that still remain Duke's A have excellent results, while patients with Duke's C or node involvement too frequently pass on at an early date. Until we know more about the cause of this disease every effort must be made to bring the cancer patient in for treatment while the disease is still a local one. More extensive surgery, which includes abdominopelvic lymph node dissection, is being investigated. More experience and additional time will be required to complete the evaluation of radical abdominoperineal resections plus pelvic node dissections in those cases in which the disease has invaded the lateral pelvic nodes.

SUMMARY

1. Three hundred sixty-nine determinate cases of rectal cancer in patients receiving combined abdominoperineal resection of the rectum 5 or more years previously are presented.

2. The 5 year survival rate of this group for the different levels within the rectum was: 0 to 6 centimeters, 52.8 per cent; 6 to 11 centimeters, 61.8 per cent; above 11 centimeters, 72.5 per cent.

3. The 5 year survival of patients with Duke's B lesions in the lower rectum was only 44.2 per cent as compared with 64.5 per cent in the midrectum and 79.5 per cent in the upper rectum and rectosigmoid.

4. Duke's B and C lesions in the lower rectum have the greatest tendency to recur locally.

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EDITORIAL

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MARCH, 1953

LABORATORY PROCEDURES OF USE IN THE DIAGNOSIS OF PANCREATITIS

THE diagnosis of pancreatitis, like that of any other abdominal disease, must be based on the judicious use of all information that can be obtained from a carefully taken medical history, a thorough physical examination, and appropriate laboratory procedures. The frequency with which this diagnosis is correctly made depends in large part upon the examining physician's familiarity with the clinical manifestations of the disease, and upon his readiness to consider it in the differential diagnosis of all painful conditions of the abdomen. Furthermore, it will depend upon his familiarity with other abdominal diseases, since it is often necessary to exclude these before a diagnosis of pancreatitis can be established with reasonable certainty. This does not mean that the diagnosis of pancreatitis is to be arrived at largely by a process of exclusion; on the contrary, in most instances the disease gives rise to positive manifestations the nature and pattern of which may be diagnostic.

By far the most important laboratory procedures for diagnosis during attacks of acute or relapsing pancreatitis are the tests for the concentration of amylase and lipase in the serum. Since various methods of performing these tests are in common use and since these methods differ from one another in respect to the units in which they are measured and also in respect to the range of the normal, it is impossible to discuss values for serum amylase and lipase in terms of specific values which are universally applicable. The clinician must be familiar with the range of normal for the procedure carried out by his particular laboratory. These tests are relatively simple to perform and should be carried out on every patient examined during or soon after an attack of abdominal pain the cause of which is not entirely clear. The determination of serum amylase can be used as an emergency procedure since the results may be available within an hour after blood for the test is drawn. It can therefore be very helpful to the surgeon who is trying to decide whether or not an acute abdominal episode is due to pancreatitis and hence whether or not an immediate abdominal operation is indicated. The determination of serum lipase cannot be used for such emergency purposes, since the results do not become available for 24 hours after blood is drawn.

During attacks of acute pancreatitis and also during acute exacerbations of chronic relapsing pancreatitis, there is a characteristic increase in the concentration of serum amylase or lipase or both. This increase may occur within an hour or two of the onset of abdomi-

nal pain. Following an attack the concentration of serum amylase usually returns to normal in roughly 1 to 4 days while that of serum lipase may remain increased for a longer time. Between acute seizures the concentration of these enzymes in the serum is normal. The tendency for the concentrations of both enzymes to fall to normal even at times when the clinical manifestations of the disease are continuing or increasing in severity is likely to be a source of confusion to the examining physician. The value of these tests in the diagnosis of pancreatitis often depends upon the time during the clinical course of the disease that the specimens are obtained, and it is often worth while to repeat the tests, especially if exacerbations of abdominal pain occur.

Increased concentration of the serum enzymes is not always found even during proved attacks of pancreatitis. This can sometimes be explained on the basis of such extensive damage to the acinar cells of the pancreas that they are rendered incapable of elaborating the enzymes. In other instances it has been attributed to the lack of obstruction to the pancreatic ducts, which seems to be an important factor in the mechanism by which increase in concentration of serum enzymes is brought about. It seems likely that there are other, as yet unknown, factors related to this mechanism.

Increased concentrations of serum amylase and lipase during painful abdominal seizures are not pathognomonic of pancreatic disease since they may sometimes be found in the presence of acute perforation of a duodenal ulcer, in the presence of peritonitis from other causes, and in intestinal obstruction. Instances have been reported in which marked increases of enzymes have occurred following the hypodermic injection of codeine or morphine in patients who had no pancreatic disease but who were apparently sensitive to these drugs. The possibility of such extrapancreatic causes for increased serum enzymes complicates the diagnosis of pancreatitis. However, with the exception of the increases following the injection of opiates (which are rare) and for a very few of those which accompany acute perforation of a duodenal ulcer, increases of serum enzymes from extrapancreatic causes have not reached the high values usually found in acute attacks of pancreatitis. Increased concentrations of enzyme from extrapancreatic causes are relatively uncommon in comparison with those which are associated with pancreatitis.

Slight increase in the concentration of serum bilirubin giving a direct reaction to the van den Bergh test is a common occurrence among patients having acute episodes of abdominal pain due to pancreatitis. Transient increases of this type are much more frequently due to disease of the biliary tract than of the pancreas. However, they serve to focus the attention of the examining physician upon these two diagnostic possibilities and in this way may eventually lead to the diagnosis of pancreatitis. It is therefore often worth while to order a determination of serum bilirubin along with the determination of serum enzymes in patients having an attack of abdominal pain of unknown cause.

More prolonged increases of serum bilirubin of greater magnitude may occur in patients with chronic pancreatitis in whom the common bile duct has become partially obstructed as a result of inflammation or pseudocyst formation in the head of the pancreas. The clinical picture presented by a few of these patients may simulate that of patients with a carcinoma of the head of the pancreas. Abdominal surgeons occasionally effect a gratifying "cure" by performing a palliative operation to relieve jaundice in such patients, who at operation are found to have a mass in the head of the pancreas thought to be carcinoma-

tous. When the patient remains in good health for many years after the operation, it may be concluded that the jaundice was no doubt due to chronic pancreatitis.

Transient increases of blood sugar and glycosuria during attacks of abdominal pain may occasionally be the first clue to the diagnosis of pancreatitis, and are worth seeking by means of appropriate laboratory procedures. Permanent diabetes mellitus may be expected to develop at some time in as many as a fourth of the patients with chronic relapsing pancreatitis. Diabetes is a late sign, and indicates extensive destruction of the tissues of the entire pancreas. Any patient who has a long-standing history of recurring attacks of abdominal pain and in whom diabetes mellitus develops should be suspected of having chronic relapsing pancreatitis.

Roentgenograms of the region of the pancreas may show calcification in this gland which is diagnostic of chronic pancreatitis. Such calcification may be either localized or diffuse and eventually occurs in more than a third of the cases of relapsing pancreatitis. Most frequently it is seen in patients who have experienced repeated severe attacks of abdominal pain over a period of many years, but occasionally it occurs in patients who have had few or no painful abdominal seizures. Pancreatic calcification seen on the roentgenogram may represent either calculi situated in the ducts or areas of diffuse calcification in the parenchyma of the gland. Often both are present in the same patient.

Aside from the disclosure of pancreatic calcification, roentgenograms are not often helpful in establishing the diagnosis of pancreatitis except as a means of ruling out other diseases. Plain roentgenograms of the abdomen taken during an acute attack of pancreatitis may show evidence of ileus but, unless pancreatic calcification is present, do not give any indication of the cause of this condition. Roentgenograms of the stomach and duodenum may at times reveal duodenal obstruction brought about by the enlarged and inflamed head of the pancreas. Rarely an obstruction of the transverse colon in the region of the splenic flexure secondary to pancreatitis may be demonstrated by means of a barium enema, but this cannot be satisfactorily differentiated from a carcinoma of the colon.

More than a fourth of the patients with chronic relapsing pancreatitis develop steatorrhea due to insufficiency of external pancreatic secretion. This, like diffuse pancreatic calcification and diabetes mellitus, is a late manifestation of the disease. It occurs only when destruction of the pancreas has been extensive or, more rarely, when the pancreatic ducts are obstructed by calculi, surrounding inflammatory tissue, or pseudocyst formation. A severe degree of pancreatic insufficiency causes a diarrhea characterized by fatty, malodorous, or voluminous stools and is often associated with considerable loss of body weight and strength. Its existence is practically certain if the patient passes large quantities of fat or oil which separate from the nonfatty portion of the fecal material. Microscopic examination of the feces may give evidence of pancreatic insufficiency if great numbers of undigested muscle fibers are found following the ingestion of meat cooked rare, or if excessive numbers of fat globules are seen when the patient is taking no excess of fat in his diet. The presence of steatorrhea and azotorrhea (excessive quantities of nitrogen in the feces) may be confirmed by quantitative fecal analyses.

When pancreatic insufficiency occurs as a consequence of chronic or relapsing pancreatitis, other evidences of this disease are usually present such as a long-standing history of recurring attacks of characteristic abdominal pains, pancreatic calcification, and diabetes.

The demonstration of steatorrhea, therefore, is usually not necessary from the standpoint of establishing the diagnosis of pancreatitis. However, in a few cases in which other evidences of the disease are equivocal or absent, the demonstration of steatorrhea, either with or without associated azotorrhea, may be of considerable diagnostic importance.

Another procedure which can be of use in the diagnosis of chronic pancreatitis is the analysis of duodenal contents after stimulating the flow of pancreatic juice by the intravenous injection of secretin. Measurement of the total volume of the secretion, its bicarbonate content, and its amylase content has been of value in determining the existence of a deficiency of the pancreatic secretion. As in the case of the fecal studies for steatorrhea, the secretin test in chronic pancreatitis is not usually necessary from a diagnostic standpoint since other definite evidences of the disease are usually present, and are much more easily obtained. However, in some cases this may be the only diagnostic procedure to give definite evidence of pancreatic disease. The major disadvantages of the secretin test are that it is time-consuming and requires the prolonged attention of a skilled technician as well as a good deal of co-operation on the part of the patient. The test must be very carefully performed in order to be reasonably certain that the results have significance. It is not needed frequently enough to make practical its establishment as a routine laboratory procedure, and it seems unlikely that it will ever be widely used for diagnostic purposes.

The diagnosis of pancreatitis is sometimes made for the first time at operation or at postmortem examination, either because clinical and laboratory evidences of the disease were not sufficiently clear or because they were not carefully sought out and interpreted. Increasing familiarity with the clinical and laboratory manifestations of the disease will no doubt reduce the number of undiagnosed cases. It may be hoped that new laboratory procedures will be devised which are even more helpful than those now in use.

ERIC E. WOLLAEGER.

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THE BOOK SHELF

ECK'S FISTULA

CHARLES G. CHILD, III, M.D., New York, New York

WITH the recent renewed interest in the treatment of portal hypertension by means of portal decompression, no article has been quoted more often than has that of Nikolai Eck. Because Eck's original article was published in Russian in *The Military Medical Journal* (1) it has never been readily available to those in this country interested in this field of vascular surgery. It has seemed worth while, therefore, to publish a translation of this classical essay. A photostat of the original was obtained from the Surgeon General's Library and translated by Dr. Ilia N. Kovarsky, Recording Secretary of the Russian Medical Society of New York City.

In reviewing this article, two facts are of especial interest. First, Eck suggested that his shunt might prove useful in man for the control of ascites, not in the management of patients with esophagogastric hemorrhage from a varix. Second, Eck stated that his inspiration to devise this venous shunt was derived from an abstract of an article by B. F. Lautenbach of Philadelphia entitled "On a New Function of the Liver." The original article appeared in *The Philadelphia Medical Times*, 1876–1877, 7: 387. The abstract to which Eck refers appeared in the July issue of *The Military Medical Journal* (2). This was also translated by Dr. Kovarsky who states that the abstract follows faithfully Lautenbach's original article. For this reason, there is little purpose in publishing a translation of this abstract.

CONCERNING LIGATION OF THE VENA PORTA

Preliminary Notification by Dr. N. Eck

If the portal vein of a dog is ligated after making sure that the blood from this vein flows freely into the inferior vena cava, then this change in the direction of the blood flow and deprival of the liver of the portal blood does not cause any serious disturbance to the body. The animal recovers after such an operation, its nutritional status improves gradually, and it remains in perfect health thereafter.

By means of several experiments, including more than 60 vivisections, I have worked out a convenient method for establishing a fistula between the above mentioned veins.

With 3 longitudinal fine silk sutures, I sew the left side of the anterior surface of the inferior vena cava to the left side of the posterior surface of the portal vein. Thereafter, I sew the right side of the posterior surface of the portal vein to the right anterior part of the vena cava by means of a line of sutures alike and symmetrical with the first 3 sutures.

Sutured in this way, the veins oppose one another on approximately equal surfaces. Upon these surfaces, which are delimited by 2 rows of sutures, a fistula between the sutured veins is formed by means of a longitudinal cut of the walls. The intravascular tension presses the edges of the gash of one vein to the edges of the gash of the other vein so that any outside hemorrhage is prevented.

For the incision of the veins, I invented small scissors curved under an angle on the same plane. To each point of the scissors, a thin, long, silver wire is soldered with a steel needle at each end.

After application of the first row of sutures, by means of which the left sides of the veins are sewed, and before putting in the second row of sutures, one establishes approximately the site of the eventual incision of each vein. Throughout the entire length of this incision we introduce into either vein the wires from the ends of the scissors in such a way that the needle with the wire which is introduced at the level of the inferior suture is brought out from the lumen of the vein opposite to the superior suture. When these wires have been introduced, the right sides of the veins are sewed up. By pulling at the wires, the slightly opened scissors are introduced from below into the space between the veins. The blades of the scissors follow the wires and enter into each vein. The walls of the veins are cut by gently moving the blades of the scissors from the point of the entrance of the wires to their exit. The completion of the incision is indicated by the fact that the scissors now move freely between the veins. Afterward, the scissors with the wires are pulled out. The portal vein is ligated at the entrance into the liver by means of previously set ligature. The abdominal cavity is cleaned of blood and sewed up carefully.

According to this method, I operated on 8 dogs. Among them, 1 did not survive 24 hours, and 6 survived from 2 to 7 days. One, which was operated upon on May 28, re-

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covered completely and lived in the laboratory for 2½ months. Because of lack of attention, he ran away on August 10. The cause of death in the 7 cases mentioned was peritonitis or strangulation of the intestines and omentum.

Formation of clots in the splenic vein was found in 2 cases only in which the length of the incision did not exceed 1 centimeter; in 1 of these cases there was occlusion of the vein with enlargement of the spleen. Occlusion does not occur when the fistula is 1½ to 2 centimeters long, and the outflow of the venous blood from the abdominal organs goes on undisturbed.

This preliminary communication was stimulated by the work of Lautenbach, "On A New Function of the Liver," which I read in the "Journal Review" in the *Military Medical Journal* of July of this year.

I am conducting these experiments with the purpose of clarifying some physiological problems as well as to determine whether it would be possible to treat some cases of mechanical ascites by means of forming such a fistula.

I consider the main reason to doubt that such an operation can be carried out on human beings has been removed because it was established that the blood of the portal vein, without any danger to the body, could be diverted directly into the general circulation and this by means of a perfectly safe operation.

I made the above mentioned 8 experiments in the laboratory of Professor I. R. Tarchanow. I had to postpone further experiments because I was called to join the active army.

September 25th
October 7th, 1877

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2. Lautenbach, B. F. Abstract of "On a New Function of the Liver." Voen. med. J., St. Petersburg, 1877, 129 (10): 120–126.

REVIEWS OF NEW BOOKS

HOW are the brains to be strengthened, the sense quickened, the genius awakened, the affections raised—the whole man turned to the best account for the cure of his fellow men? How are you, when physic and physiology are increasing so marvellously, and when the burden of knowledge, . . . is so infinite: how are you to . . . bear up under all, and use it as not abusing it, or being abused by it?" (From the essay "With Brains, Sir" by John Brown, M.D., author of "Rab and His Friends)."

Doubtless the same question has troubled many a medical student and house officer, and perhaps some might wonder whether Dr. Brown's prescription—"for an hour or two twice a week (to) take up a volume of Shakespere, Cervantes, Milton . . . Scott, Charles Lamb, Thackeray . . . getting fresh, strong views of worn out, old things, and above all, learning the right use of their reason"—was an adequate answer to an important and perplexing problem. Possibly had he lived in this century instead of in the 19th Dr. Brown would have recommended that his student should spend at least a half hour each day reading the *Cyclopedia of Medicine*,[1] whose editor says in his preface to the new third edition: "It has been planned to provide a complete, compact, reference library sufficiently scientific to prove useful to teachers and investigators, as well as to medical students, interns, and residents, one that will provide specialists with complete up-to-date reviews of their respective fields; and, above all, one that in a single set of convenient books, will make available to the hard-pressed general practitioner authoritative practical information on every phase of medicine."

The field of medicine has become so vast and the effort to present an encyclopedic view of it is such a formidable undertaking that one can have only wholehearted respect and admiration for those sufficiently courageous to undertake the task. No one can overestimate the difficulties that confront the editors in planning such an enterprise, in determining what should be included, what omitted, what emphasis and space should be given to various subjects, how major subjects should be divided and, of paramount importance, whose services should be enlisted to prepare and present the many and varied subjects included.

It is obviously impossible for the reviewer of such a large amount of material to do justice to the many excellent contributions and to make individual mention of all the men who have devoted time and effort to this undertaking. The best results it would seem have been attained when one major subject has been assigned to a few contributors and they have assumed the responsibility for the complete presentation. The section on the adrenals, 132 pages in length, in Volume I, is an excellent illustration. It is divided into five well balanced parts: anatomy and physiology, diseases of the adrenals, surgery, Addison's disease and tumors, and is written by four men, Max and Joseph Goldzieher of New York, René Leriche and T. H. McGavrack of the New York Medical College. There is little "overlapping" and the section as a whole presents an excellent and comprehensive discussion of a subject of very great interest and significance. The sections on thyroid disease by contrast (Vol. XIV), and on the stomach (Vol. XIII), though excellent as a whole, are "cut up" in a fashion that leads to considerable repetition. One gathers the impression that had the subject been assigned to a few of the able contributors who have prepared different parts of these sections a well balanced presentation without unnecessary repetition would have resulted. Similar comment might be made concerning the section on tumors of the brain and the section on the breast in Volume II.

The sections on anesthesia and appendicitis, also in Volume I, are of particular excellence. The former includes well written and well illustrated sections on regional anesthesia, spinal, caudal and transsacral anesthesia, in addition to an excellent discussion of inhalation anesthesia and inhalation agents. Many of the leaders in the field of anesthesia in the entire United States,—Lundy, Tovell, Rovenstine of New York University, Nicholson of the Lahey Clinic, Cullen of the University of Iowa, and Taylor of Wayne University—are represented among the contributors. The discussion of the complications of appendicitis is complete and well illustrated. J. Montgomery Deaver of Philadelphia and A. G. Martin of Milwaukee are the authors of this excellent contribution.

In Volume II, three subjects—bladder, brain, breast—are of particular interest to surgically minded readers. Each is divided into several subdivisions and discussed by able surgeons. The section on neoplasms of the bladder by H. J. Jewett of Johns Hopkins University is comprehensive, informative and very well illustrated. The section on the pathology of the breast by W. C. MacCarty is clear and concise and well illustrated with both line drawings and photographs. One would welcome a more complete discussion of the subject of lymphatic extension and metastases of malignant growths of the breast and of the results of treatment. In spite of the many large series of cases that have been reported here and abroad and the great interest in the subject of breast cancer in Great Britain and the Scandinavian countries the discussion of the results of treatment is

[1] THE CYCLOPEDIA OF MEDICINE, SURGERY, SPECIALTIES. Editor-in-Chief, George Morris Piersol, M.D. Assistant Editor, Edward L. Bortz, M.D. 14 vols., 3rd ed. Philadelphia: F. A. Davis Co., 1952.

limited to two brief paragraphs in a section on diseases of the breast. One finds no mention of McWhirter's contributions, of the question of extended operation (Wangensteen, Dahl-Iversen), and in fact only three direct references to surgical literature with citation of year and journal.

Volume II concludes with the first papers devoted to the cardiovascular system, and these include very complete, well written and illustrated discussions of congenital anomalies of the heart and great vessels and their surgical treatment. Other papers on the cardiovascular system, including discussions of rheumatic heart disease, electrocardiography, pericarditis, hypertension and diseases of the blood vessels take up the greater part of Volume III.

In Volume IV are included discussions upon ulcerative colitis by Bargen and a well illustrated discussion on surgery of the colon by Rankin and Graham. The latter have included a résumé of Graham's analysis of the attitude of fifty experienced surgeons upon the vexing questions of preoperative drainage in the presence of cancer of the colon, of obstructive resection and of primary anastomosis. In the discussion of megacolon by Bartle no mention is made of the absence of ganglion cells in the nondilated rectosigmoid, and surgical resection of this segment (Swenson, 1949). Discussions of diseases of the conjunctiva by Thygeson of the University of California, of the cornea by Kirby of New York University (both chapters illustrated with some excellent plates in color), of congenital deformities, particularly those of the lower extremities by Moore and Nicholson of Philadelphia, and of diaphragmatic hernia by Harrington of the Mayo Clinic, all unusually well illustrated, are also included in Volume IV.

A comprehensive section on endocrinology, chapters on endometriosis by Jean Pratt of the Henry Ford Hospital, on endoscopy by L. H. Clerf, on the esophagus by the Jacksons of Philadelphia, on strictures and benign tumors of the esophagus by Ralph Adams and Walter Hoover, and on congenital atresia by George Humphreys of New York are included in Volume V. The very excellent section on fractures makes up the last third of this volume (330 pages). Michael Scott (the skull), Robert Ivy (the bones of the face), Robert Joplin of Boston (the clavicle scapula, sternum and ribs), H. Osmond Clarke (the upper extremity), J. Albert Key (the lower extremity), Theo. Brookes (the cervical spine), W. A. Rogers (thoracic and lumbar vertebrae), George Bennett and George Eaton (pelvis) have all contributed chapters that help to make this an exceptional volume.

Hand infections, the head, hematology in Volume VI; the intestines, with excellent sections on obstruction of the small and large intestine; joints and a 230 page section on the kidneys in Volume VII; the larynx, liver and biliary tract, lungs and lymphatics in Volume VIII are major subjects that are exceptionally well covered. Liver function tests (J. G. Mateer, J. I. Baltz, and H. H. Steele of the Henry Ford Hospital); cirrhosis of the liver and chronic hepatitis with jaundice (A. M. Snell and H. R. Butt of the Mayo Clinic); the x-ray examination of the biliary tract (Arthur and Leah Finkelstein of the Graduate School of Medicine, University of Pennsylvania); the surgery of the gallbladder and biliary ducts (John Paul North, Southwestern Medical School); the pneumoconioses (E. Mayer of New York University and I. Rappaport of Columbia University); and pulmonary and mediastinal cysts (W. E. Adams, University of Chicago), all well documented with references from the work of others, are chapters on important subjects which are particularly well presented.

Metabolism, muscles, nerves; the osseous system beginning in Volume IX and continued in Volume X; the pancreas, pleura, pituitary gland, pneumonia; pregnancy, parturition and the puerperium (Vols. X, XI); the prostate, psychiatry, and radiology are broad subjects of general interest included in Volumes IX, X, and XI. The sections included under the latter two subjects, psychiatry and radiology, and continued in Volume XII, are comprehensive presentations that help to make Volumes XI and XII outstanding ones. Psychoanalysis (K. E. Appel and M. R. C. Astley, University of Pennsylvania), child psychiatry (S. A. Guttmann, University of Pennsylvania), the psychoneuroses by a group of contributors, the majority associated with the department of neuropsychiatry of the University of Pennsylvania, are all presented with unusual clarity and helpful understanding. The chapters on planigraphy (G. N. Stein, University of Pennsylvania), roentgenologic diagnosis of the skull and brain (J. D. Camp, Mayo Clinic), roentgen examination of the small intestine and of the stomach (J. H. and Mary Vastine, Woman's Medical College of Pennsylvania), and roentgen diagnosis of organic lesions of the large intestine (H. M. Weber, Mayo Clinic) are all beautifully illustrated with roentgenograms of unusual clarity that add greatly to the presentation and do credit both to the authors and the publishers.

Sections on the rectum and anus, with a chapter on cancer by L. K. Ferguson (Woman's Medical College of Pennsylvania), on rehabilitation (Howard Rusk), comprehensive sections on spleen, stomach, sympathetic nervous system, testis (Vol. XIII), and on tuberculosis, ureters, uterus, vascular diseases and vascular tumors (Vol. XIV) would constitute admirable "refresher courses" for Dr. Brown's student, mentioned above, who is attempting to keep abreast of the many rapid advances in physic and physiology.

Although one would give wholehearted approbation of this achievement as a whole, not every reader will be completely satisfied. The surgically minded reader for example may say he would gladly forego the extensive discussion of drugs, whose chemical structure and action can readily be found in textbooks of pharmacology and materia medica, in exchange for more extended consideration of important surgical subjects. Fifteen and 14 pages for example,

are devoted to arsenic and arsphenamine, 13 to iodine and iodides, 9 to belladonna, and by contrast 2½ pages to penicillin, less than 2 pages each to aureomycin and to streptomycin. Instead of very brief mention of individual antibiotics one would welcome a comprehensive discussion of the major subject of antibiotic therapy.

Only 11 pages are devoted to surgical infections, a problem that confronts both the general practitioner and the surgeon almost daily and one to which distinguished surgeons have devoted entire volumes. The subject of infections of the hand, in contrast to that of surgical infections in general, is admirably covered in a well illustrated, 43 page discussion that leaves little to be desired.

Four pages are devoted to shock, a *bête noire* of both surgeon and general practitioner; 6 pages to silver, immediately following. Scarlet fever, a nearby neighbor of shock, is allotted 72 pages. In a 66 page chapter on preoperative and postoperative treatment, under the heading "Surgery," there is a single page devoted to "Blood and 'Blood Substitutes' in Shock."

One disturbing inconsistency concerns the inclusion of references as a part of individual contributions. In some chapters notable and important contributions are cited; often no references whatever are included; occasionally references are made almost exclusively to other publications by the author—a custom in medical writing fortunately more honored in the breach than in the observance. To the reader who would go further in a subject of particular interest references to contributions that the author has found valuable can be exceedingly helpful.

To please every reader and to attain perfection in an undertaking of such magnitude obviously are impossible achievements. The medical profession can do no less than award great credit to the editors and to the contributors to this very extensive and admirable compendium of medical knowledge.

SUMNER L. KOCH.

THE volume *Culdoscopy; a New Technic in Gynecologic and Obstetric Diagnosis*[1] by Albert Decker is written in response to requests from the author's colleagues for information concerning the details of culdoscopy. Decker, who is responsible for the development of the procedure, also has created the instruments used for it.

The indications and contraindications for culdoscopy, its value as a diagnostic procedure, and the author's experience in its use in cases of tubal pregnancy, sterility problems, and endometriosis are given in detail. Positioning the patient, anesthesia, the instruments used, and endoscopic photographic methods are described. The author discusses colpoceliocentesis, ectopic pregnancy, sterility, uterotubal insufflation, pneumoperitoneum, the diagnosis of endometriosis, and observation of ovulation and ovum transfer. The illustrations by William Didusch and Alfred Feinberg are well done.

Culdoscopy is a new procedure and is not, as yet, used by most gynecologists. Time and experience will determine the extent to which it will replace colpotomy. Decker's comprehensive yet concise monograph is required reading for those who wish to know more about it and for the gynecologist who wishes to employ it.

JOHN W. HUFFMAN.

[1]CULDOSCOPY; A NEW TECHNIC IN GYNECOLOGIC AND OBSTETRIC DIAGNOSIS. By Albert Decker, M.D., D.O.G., F.A.C.S. Philadelphia, London: W. B. Saunders Co., 1952.

A VERY sincere attempt is made by J. Jay Rommer in *Sterility; Its Cause and Treatment*[2] to encompass all aspects of an exceedingly complex subject. Anatomical, psychological, normal medical, surgical and environmental problems, endocrine factors, the size and structure of the genitals, congenital anomalies and gynecologic pathology are all considered in detail in relation to infertility in the female. The medical treatment and surgical management of disorders which may, in any way, be associated with infertility are either briefly mentioned or discussed in detail. The problem of the infertile male, although less comprehensively considered than that of the female, is dealt with in the same inclusive fashion.

A tremendous amount of effort has been expended in assembling the comprehensive references appended to each chapter. This is particularly true of the more inaccessible literature published prior to 1945. Considering the innumerable contributions to the subject in recent years, it is inevitable that the reader particularly interested in sterility will note their absence. Although somewhat incomplete, the bibliographic material which the book contains is perhaps one of its most valuable assets.

Unfortunately, and perhaps inevitably, in a first edition there are things which will be either questioned or criticized adversely. Among those noted by this reviewer were the description of ovarian arrhenoblastoma and the comments relative to smoking and climate as related to infertility. The discussions of endometriosis and uterine myomas as related to infertility, the use of polyethylene tubing in uterine tubal plastics, and Heckel's work on testosterone and spermatogenesis might advantageously have been elaborated upon.

Although many of those who read Rommer's text will probably disagree with quite a few of his observations, they will find it an interesting compendium of the literature on sterility.

JOHN W. HUFFMAN.

THE neuroanatomical section of the *Stereoscopic Atlas*[3] by D. L. Bassett, Associate Professor of Anatomy, Stanford University, may be enthusiastically recommended to students, teachers, and practitioners as a brief, highly accurate, and pictorially excellent survey of human anatomy, executed with technical skill and presented with artistic judgment.

[2]STERILITY; ITS CAUSE AND TREATMENT: PT. I, THE INFERTILE FEMALE; PT. II, THE INFERTILE MALE. By J. Jay Rommer, A.B., Ph. G., M.D., A.I.C.S. Springfield, Ill.: Charles C Thomas, 1952.

[3]A STEREOSCOPIC ATLAS OF HUMAN ANATOMY, SECTION I—THE CENTRAL NERVOUS SYSTEM. By David Bassett, M.D., and W. B. Gruber. Portland, Oregon: Sawyer's Inc., 1952.

The series offers opportunity for convenient review of dissection. Each dissection represents a step in a series in a carefully planned succession; each is seen in full perspective and in the coloring of admirably preserved laboratory material.

An amply labeled sketch, based upon a tracing of the original photograph, furnishes a topographical "map" for each view; the views themselves are not marred by pins, numbers, or guidelines. The stereoscopic pictures record, remarkably well, essential and unobstructed perspective; exceptionally fine illumination of deep-lying structures, recesses, sulci and formina aids in contributing naturalness to dissection-field.

In preparing the several sequences, the same specimen was used, so far as possible, for the successive dissections in each series—to give a unity that otherwise would be lacking. Relations are presented exactly as they existed in the parts dissected.

The set is compact, the views readily accessible; the views may be regrouped to answer the needs of regional review; selected elements of the present lot may, later, be interpolated, on the basis of system, in sets which the author and publisher plan to provide.

The present set of views make up Section I of *A Stereoscopic Atlas of Human Anatomy*. It covers the central nervous system (including the brain, spinal cord and meninges). Sections II to VII are in preparation. This ambitious atlas consists of 238 three-dimensional kodachrome transparencies in full color, on 34 reels. The reels are stored, protectively, in numbered slots at the back of each of the four volumes of text. A table of contents, like that of a textbook, lists the title of each view and the features illustrated in each view. The reels are accompanied by 500 pages of text which present pertinent information and drawings—each of the latter being fully labeled, provided with a scale of dimensions and suitable description. Reference is rendered ready and easy by a cross index which lists more than 5,000 terms.

The reels of pictures are to be used with Sawyer's View-Master stereoscope. In addition to being usable by the individual, the pictures may be projected on a screen, for instruction of classes and seminars in school, hospital or clinical meeting. By wearing polaroid glasses, members of an audience obtain a three-dimensional effect matching that of the individual user of the stereoscope.

Dr. Bassett's experience as a teacher, and his exceptional ability as a critical anatomist would, of course, guarantee the quality of this set. He is most fortunate in having the technical collaboration, in capacity of photographer, of Mr. William B. Gruber, designer of the stereoscope which accompanies the reels and text. Mr. Gruber's skill is as essential to such an endeavor as that of an artist is to the anatomist who prepares a textbook or atlas of the more familiar kind. To the publisher's statement that "there is something new in anatomy" we gladly, and praisefully, record assent. BARRY ANSON.

THERE seems little question that the autobiography of Dr. William Sharpe[1] will become a best seller. The story is vividly written with the dramatic quality of fiction. It tells of the transition from the life of poverty in a minister's family to that of a surgeon with an extensive and financially fruitful practice. The chapters dealing with his student life at Harvard, in Germany, and in medical school are exciting reading to the layman and doctor alike. The layman will enjoy each chapter and will avidly read each surgical accomplishment with the same fascination that a physician might read a thrilling mystery or story of legal or engineering brilliancy. Physicians will question the wisdom and propriety of the not too modest medical and surgical inclusions in his book. Neurologists and neurosurgeons will certainly question the propriety and accuracy of his descriptions of the diagnosis and treatment of birth injuries and spastic paralysis, which play such an important part in his autobiography. Many will question the lack of dignity that exists in the author's writing of being asked to sire an offspring for a nonfertile father. While this instance and a few others may well have been part of the author's experiences in life and in his medical practice, their inclusion in an autobiography of a successful physician seems somewhat out of order. The story would have been better if it had been a fictional biography.

DAVID CLEVELAND.

IN the second edition of his book, *Architectural Principles in Arthrodesis*,[2] the author presents his methods of arthrodesis based on architectural principles. This time the number of cases of each type, together with the results, are tabulated. Some of the procedures have been modified as the author's experience has guided him. Other methods have been discussed for the first time. Underlying each is the adaptation of the mechanical principles utilized in cathedral structure.

In the early chapters, he discusses the indications for arthrodesis and causes for failure of fusion. He believes that a bone graft should be used in every operation for arthrodesis. He prefers autogenous tibial grafts for reasons that he enumerates.

The architectural principles that he has listed are: (1) the graft should be placed with its long axis in compression rather than in tension; (2) the breadth of the graft should be placed in the position of maximum stress; (3) the joint should be locked by two grafts crossing each other in the shape of the letter X; and (4) there should be adequate protection of the graft. It is not possible, however, to adapt all of these principles to each arthrodesing procedure.

In the balance of the book he shows how these principles have been adapted to each joint. The

[1] BRAIN SURGEON; THE AUTOBIOGRAPHY OF WILLIAM SHARPE. New York: The Viking Press, 1952.

[2] ARCHITECTURAL PRINCIPLES IN ARTHRODESIS. By H. A. Brittain, O.B.E., M.A., M.Ch., F.R.C.S. With a foreword by Sir Harry Platt, M.D., M.S., F.R.C.S., F.A.C.S. (Hon.) 2nd ed. Edinburgh, London: E. & S. Livingstone Ltd.; Baltimore: The Williams & Wilkins Co., 1952.

operative technique is given in detail, including the fashioning of the tibial graft and its placement. The largest series presented is that of the ischiofemoral arthrodesis in which the author has over 80 per cent fusions in 154 hip operations. The author has included in this edition, a chapter in which he describes the technique of the Naughton Dunn foot arthrodesis.

The monograph is well illustrated with reproductions of roentgenograms. There are also several fine colored prints and diagrammatic representations of various arthrodesing operations.

ROBERT H. CASSIDY.

THE publication of *Ophthalmic Pathology*,[1] eagerly awaited by the ophthalmological world, coincided opportunely with the 1952 meeting of the American Academy of Ophthalmology and Otolaryngology, one of its co-sponsors. It combines the sterling features of *Atlas of Ophthalmic Pathology*, which appeared first in 1938, and *The Pathology of the Eye* by Jonas S. Friedenwald (published in 1929), two classics in American ophthalmologic literature.

The number of photomicrographs greatly exceeds that of the original atlas. Some of the old illustrations have been retained; others refer to different sections of the same specimens presenting a more characteristic aspect of the disease. Still others are taken from entirely different eyes. To illustrate the great care which must have entered into the selection of the illustrations, one should compare the somewhat unsatisfactory photographs of Coats' disease in the old edition with the splendid pictures in the new book. The material is brought up to date with thrilling reproductions on toxoplasmosis, retrolental fibroplasia, and diabetic retinopathy (emphasizing our present concepts of the latter disease). By slightly decreasing the size of the individual samples and grouping several of them on one plate, much wasted space has been eliminated; a wealth of material has been accumulated in a relatively concise volume.

The text, based on Friedenwald's little volume, exceeds it enormously in scope. Where there is only a broad outline in the original, minutest details are covered in the new book. There are introductory chapters on anatomic and physiologic considerations, histology, growth and aging, and the nature and mechanism of inflammation. Inflammatory lesions are covered in 3 chapters. The remaining 11 chapters correspond to the subdivisions of *The Pathology of the Eye*, with minor variations, but in greatly expanded form. The appendix of microscopic technique has not been retained. One may rightly argue that, in order to bring this subject up to the standards of high quality of the book, it would have been necessary to include material available elsewhere. Such an increase in size would have added little to the usefulness of the volume.

Though it is modestly claimed in the preface that the book is intended as a teaching aid rather than a reference, the text references and general references appended to each chapter should prove to be adequate for further investigation of specific problems.

All contributors, including the publisher, deserve the highest praise of ophthalmologists throughout the world for their achievement. They have created a new criterion of excellence on which similar publications will have to be judged in the future.

STEFAN VAN WIEN

THE 1952 volume of *Monographs on Surgery*[2] contains a number of important and well written contributions. Allen Whipple's discussion of "The Radical Surgery of Pancreaticoduodenal Cancer" is a thoughtful survey of this important problem by the man who blazed the surgical pathway and did more than anyone else to stimulate the interest of surgeons in the radical and curative treatment of this lesion, so long regarded as unapproachable and hopeless from the standpoint of surgical treatment. He concludes with the statement, "The future hope for improvement in the prognosis following the radical surgery for these lesions lies not in studying these elderly patients, with cardinal symptoms of jaundice, of constant severe epigastric pain radiating to the back, for periods of weeks with watchful waiting, (but in) ... early operation if the diagnosis is not clear, or if the diagnosis is reasonably established, in urging immediate surgery by a competent surgeon."

A comprehensive review of the entire subject of renal neoplasms by Willet F. Whitmore, Jr. lays particular stress upon the various pathologic types and their incidence, upon diagnosis, upon prognosis, based upon the results in a considerable number of different series of cases, and upon surgical and radiologic treatment.

Freeman's chapter upon "Surgery of the Large Arteries" emphasizes both the dangers and the possibilities of arteriography, a method of diagnosis that will undoubtedly find constantly increasing indications if completely innocuous contrast media can be developed, and when techniques of injection and radiography are perfected. Freeman's contribution is well illustrated with a number of excellent roentgenograms.

Curtis and Meckstroth's clear and concise discussion of "Radioactive Iodine in the Diagnosis and Treatment of Thyroid Disease" is an excellent and understandable description of the physical characteristics and sources of radioisotopes, of the action of

[1] OPHTHALMIC PATHOLOGY; AN ATLAS AND TEXTBOOK. By Jonas S. Friedenwald, Helenor Campbell Wilder, A. Edward Maumenee, T. E. Sanders, John E. L. Keyes, Michael J. Hogan, W. C. and Ella U. Owens. With the editorial assistance of Helen Knight Steward. Published under the joint sponsorship of The American Academy of Ophthalmology and Otolaryngology and The Armed Forces Institute of Pathology. Philadelphia, London: W. B. Saunders Co., 1952.

[2] MONOGRAPHS ON SURGERY, 1952. B. Noland Carter, M.D., Ph.D., Editor. Advisory Editors: Gynecology—Joe V. Meigs, M.D., Urology—Charles Huggins, M.D., Orthopedic Surgery—Alfred R. Shands, M.D. Baltimore: The Williams and Wilkins Co., 1952.

radioactive iodine, and of its usefulness in diagnosis and treatment.

Orthopedic surgery is well represented in this volume by excellent and well illustrated chapters on "Internal Fixations of Fractures of the Shafts of the Long Bones" by G. W. N. Eggers; "Intracapsular Fractures of the Femoral Neck: Their Care and Complications" by E. R. Schottstraedt, L. J. Larsen, and F. C. Bost; "Aseptic Necrosis of the Femoral Head in Adults" by William Cooper; and "Arthroplasty" by Robert A. Knight. Every surgeon who is confronted with the problem of treating fractures of the femoral neck, particularly in the elderly patient, will find help and sage advice in these comprehensive and thoughtfully written papers.

A symposium on "Urinary Incontinence in the Female" is prefaced by an excellent discussion by S. Richard Muellner, illustrated with well chosen radiograms, to demonstrate the physiological action of the bladder and urethral musculature and the etiology of urinary stress incontinence. This is followed by five papers on surgical and physiologic treatment.

Chapters on "The Management of Acute Chest Injuries" by Brian Blades and R. C. Garby, and on "Congenital Ureteral and Pelvic Dilatation as Evidence of Obstruction" by Frank Hinman, Jr. complete the list of contributions in this excellent group of monographs on surgery.

SUMNER L. KOCH.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

LES FROTTIS VAGINAUX ENDOCRINIENS; BASES BIOLOGIQUES ET INDICATIONS CLINIQUES GYNÉCOLOGIQUES. By J. Paul Pundel with collaborations by R. Vokaer and Z. Jaworski. 2nd ed. Liège: Éditions Desoer; Paris: Masson et Cie, 1952.

BODY TEMPERATURE; ITS CHANGES WITH ENVIRONMENT, DISEASE AND THERAPY. Publication No. 147, American Lecture Series. A Monograph in American Lectures in Physical Medicine. By W. A. Selle, Ph.D. Springfield, Ill.: Charles C Thomas, 1952.

CHIRURGIE DES VOIES BILIAIRES DE L'ADULTE ET DU NOURRISSON; TECHNIQUE ET TACTIQUE. By M. Champeau and P. Pineau. With collaboration by A. Prochiantz and Mme S. Desvignes. Paris: Masson et Cie, 1952.

HERNIA; ANATOMÍA, ETIOLOGÍA, SÍNTOMAS, DIAGNÓSTICO, DIAGNÓSTICO DIFERENCIAL, PRONÓSTICO Y TRATAMIENTO. By Leigh F. Watson, M.D., F.I.C.S. 1st ed. With assistance by the translators, Drs. Diego E. Zavaleta and Julio V. Uriburu. Buenos Aires: Editorial Artécnica, 1952.

CHEMICAL INDUCTION OF CANCER. By George Wolf, B.Sc., D.Ph. Cambridge: Harvard University Press, 1952.

VISUAL ANATOMY; THORAX AND ABDOMEN. By Sydney M. Friedman, M.D., Ph.D. 1st ed. Springfield, Ill.: Charles C Thomas, 1952.

ACUTE RENAL FAILURE; INCLUDING THE USE OF THE ARTIFICIAL KIDNEY. By John T. MacLean, M.D., F.R.C.S. (C)., F.A.C.S. Springfield, Ill.: Charles C Thomas, 1952.

GYNECOLOGY; DISEASES AND MINOR SURGERY. Compiled and edited by Robert J. Lowrie, M.A., M.D., F.A.C.S., D-OG. Foreword by Claude E. Heaton, M.D. 1st ed. Springfield, Ill.: Charles C Thomas, 1952.

ANALGESIA AND ANESTHESIA IN OBSTETRICS. Publication No. 159, American Lecture Series. A Monograph in American Lectures in Gynecology and Obstetrics. By J. P. Greenhill, M.D. Edited by E. C. Hamblen, M.D., F.A.C.S. Springfield, Ill.: Charles C Thomas, 1952.

CLINICAL OBSTETRICS. By members of the Staff of the Pennsylvania Hospital. Edited by Clifford B. Lull, M.D., and Robert A. Kimbrough, M.D. Philadelphia, London, Montreal: J. B. Lippincott Co., 1953.

DISEASES OF THE ESOPHAGUS. By Philip Thorek, M.D., F.A.C.S., F.I.C.S. Philadelphia, London, Montreal: J. B. Lippincott Co., 1952.

NURSES HANDBOOK OF OBSTETRICS. By Louise Zabriskie, R.N., and Nicholson J. Eastman, M.D. 9th rev. ed. Philadelphia, London, Montreal: J. B. Lippincott Co., 1952.

THE TREATMENT AND CLASSIFICATION OF CANCER. By James C. Lees and Thomas W. Lees. Edinburgh: Oliver and Boyd Ltd., 1952.

HANDBOOK OF GYNAECOLOGICAL DIAGNOSIS FOR PRACTITIONERS AND STUDENTS. By Walter Neuweiler, M.D. Translated from the German by Dr. Paul Ederer. New York: Grune & Stratton, 1952.

PHEOCHROMOCYTOMA AND THE GENERAL PRACTITIONER. By Joseph L. DeCourcy, M.D., and Cornelius B. DeCourcy, M.D. Cincinnati: DeCourcy Clinic, 1952.

COLLEGIATE EDUCATION FOR NURSING. By Margaret Bridgman. New York: Russell Sage Foundation, 1953.

GYNECOLOGICAL AND OBSTETRICAL PATHOLOGY. By Peter A. Herbut, M.D. Philadelphia: Lea & Febiger, 1953.

ESTERILIDAD POR FACTOR CERVICAL; ANATOMIA, FISIOLOGIA CLINICA Y TRATAMIENTO. By Carlos A. Paradelo, José María E. Mezzadra, and Alberto E. Bettinotti. Prologue by Prof. Juan Carlos Ahumada. Buenos Aires: Editorial Vergara, 1953.

HANDBOOK OF ORTHOPAEDIC SURGERY. By Alfred Rives Shands, Jr., B.A., M.D. In collaboration with Richard Beverly Raney, B.A., M.D. 4th ed. St. Louis: The C. V. Mosby Co., 1952.

PATHOLOGY IN SURGERY. By Edwin F. Hirsch, Ph.D., M.D. Baltimore: The Williams & Wilkins Co., 1953.